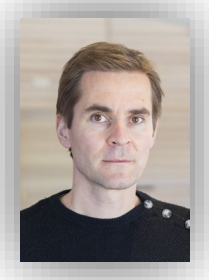
Bioinformatics and Digital Health

Aalto University
School of Science

Bioinformatics and Digital Health at CS/Aalto

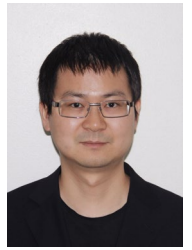


Assoc. Prof. H. Lähdesmäki
- Computational biology
- Deep generative modeling
- Probabilistic ML

Prof. J. Rousu
- Predicting structured data
- Kernel methods
- Computational biology

Assoc. Prof. P. Marttinen
- Bioinformatics
- Statistics
- Probabilistic ML

Assist. Prof. V. Gary
- Bioinformatics
- Statistics
- Probabilistic ML

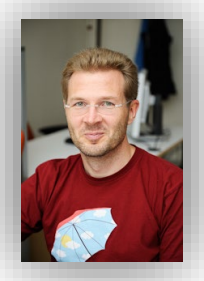


Acad. Fellow L. Cheng
- Bioinformatics
- Statistics
- Biomedicine

Prof. S. Kaski
- Probabilistic ML
- Computational medicine
- User interaction

FiDiProf. H. Mamitsuka
- Bioinformatics

Prof. P. Orponen
- Natural computation
- DNA self-assembly
- Stochastic and online algorithms



Prof. A. Vehtari
- Bayesian inference
- Probabilistic modeling
- Machine learning

Prof. of practice J. Kaipio
- Usability of healthcare IT systems
- Patient experience

Prof. Emeritus K. Kaski
- Complex systems

Aalto University
School of Science

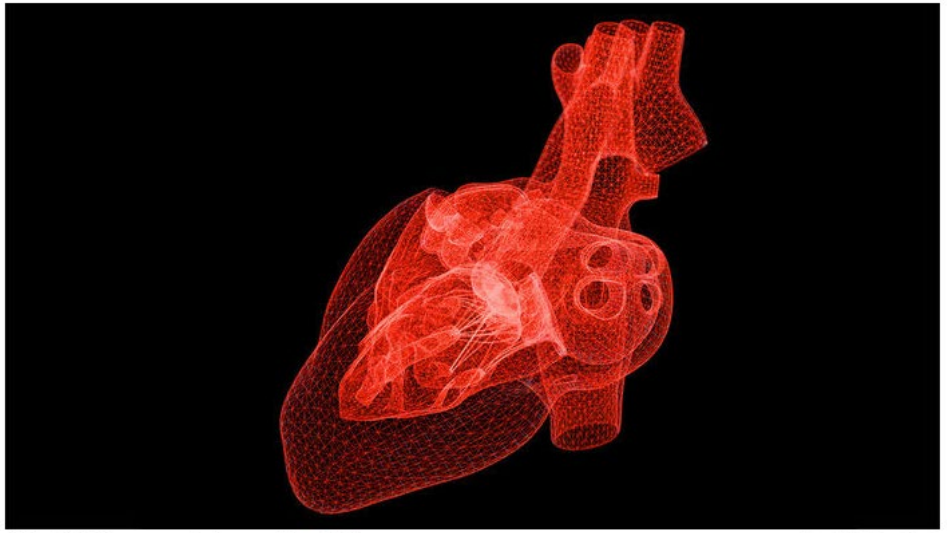
Computational methods have become central in biomedical research

AI protein-folding algorithms solve structures faster than ever

Deep learning makes its mark on protein-structure prediction.

Matthew Hutson

(Nature, 2019)



Artificial intelligence may help prevent heart failure. Devrimb/iStockphoto

Self-taught artificial intelligence beats doctors at predicting heart attacks

By Matthew Hutson | Apr. 14, 2017 , 3:30 PM

(Science, 2017)

Computational methods have become central in biomedical research

AI-powered drug discovery captures pharma interest

Eric Smalley

Nature Biotechnology **35**, 604–605 (2017) | doi:10.1038/nbt0717-604
Published online 12 July 2017

KTSDESIGN/Science Photo Library

TECHNOLOGY FEATURE

THE BIG CHALLENGES OF BIG DATA

As they grapple with increasingly large data sets, biologists and computer scientists uncork new bottlenecks.

Bioinformatics & DH **major**

- Main theme:
  - Use ML / Stats / AI to answer various health and bio questions
- Courses in:
  - Bioinformatics and computational biology
  - Machine learning, statistics
  - State-of-the-art ML / AI methods applied to biological problems
- For those who:
  - Have a quantitative mind-set
  - Interested in ML / Stats / CS / AI / Math / …
  - Interested in solving biological / medical problems

Compulsory courses of the programme (10 credits):

[illegible]	Life Science Technologies Project Course A	2	I/1
JOIN-E3200	Life Science Technologies Project Course B	8	III-V/1

Compulsory courses of the major (minimum of 30 credits):

A. Courses on bioinformatics and digital health (choose minimum of 15 credits):

CS-E5865	Computational Genomics	5	I/1
CS-E5875	High-throughput Bioinformatics	5	II/1
CS-E5885	Modelling Biological Networks	5	III/1
CS-E5890**	Statistical Genetics and Personalised Medicine**	5	IV-V/1*
CS-E4880**	Machine Learning in Bioinformatics**	5	IV-V/1*
CHEM-E8120	Cell Biology	5	II/1

B: Courses on probabilistic modeling and machine learning (choose minimum of 15 credits):

CS-E4710	Machine Learning: Supervised methods	5	I-II/1
CS-E5710	Bayesian Data Analysis	5	I-II/1 or 2
CS-E4890	Deep Learning	5	IV-V/1
CS-E4820	Machine Learning: Advanced Probabilistic Methods	5	III-IV/1
CS-E4840	Information Visualization	5	IV-V/1
CS-E4830	Kernel Methods in Machine Learning	5	IV-V/1
CS-E4895	Gaussian Processes	5	IV-V/1

Optional courses of the major (choose courses to fulfill the 60 credit requirement):

“Teaching philosophy”

- Give a strong methodological background

  \+ **focus on methodological principles and basic science which does not get outdated soon**

  \+ spezialize in bioinformatics and computational methods

  \+ basic knowledge of applications (biology, biotechnology)

  = M.Sc. degree in biological data analysis — expertise for a variety of jobs

- Provides excellent prospects for doctoral studies and R&D

Bioinformatics & DH **minor**

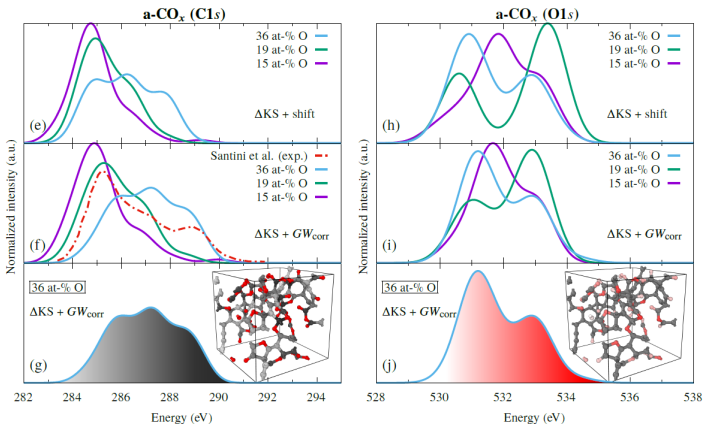
Structure of the minor

Code	Name	Credits
Compulsory courses (choose minimum of 20 credits):		
MS-C1620	Statistical Inference	5
CS-E5865	Computational Genomics D	5
CS-E5875	High-throughput Bioinformatics D	5
CS-E5885	Modelling Biological Networks D	5
CS-E5890	Statistical Genetics and Personalised Medicine D*	5
CS-E4880	Machine Learning in Bioinformatics D*	5
*CS-E5890 and CS-E4880 are lectured every other year (alternating). CS-E5890 is lectured in odd years and CS-E4880 is lectured in even years.		
Elective courses (select 5 credits if needed):		
CS-E4710	Machine Learning: Supervised methods D	5
CS-E4830	Kernel Methods in Machine Learning D	5
CS-E4820	Machine Learning: Advanced Probabilistic Methods D	5
CS-E4890	Deep Learning	5

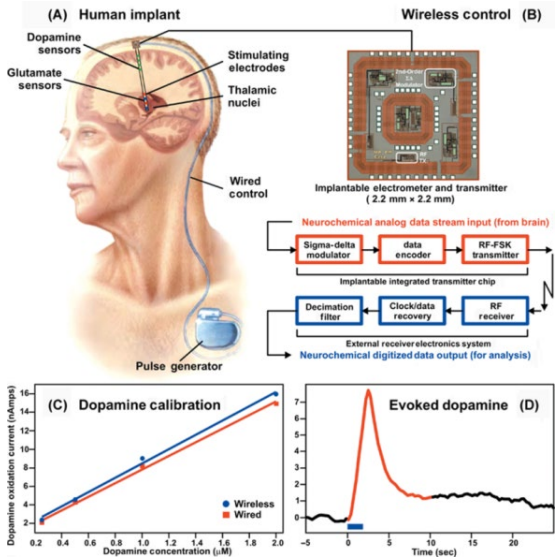
Biosensing and Bioelectronics

Biosensing and –electronics

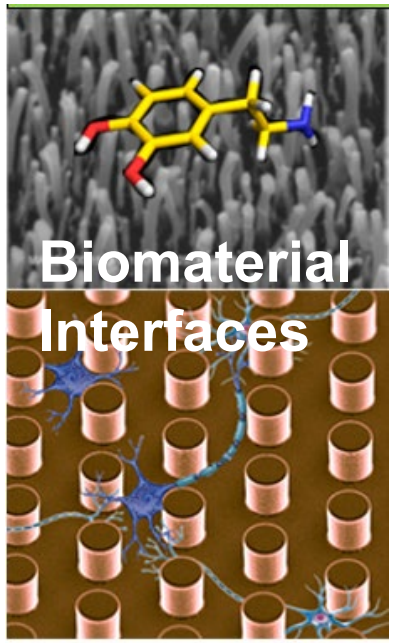
FinnCERES Materials Cluster



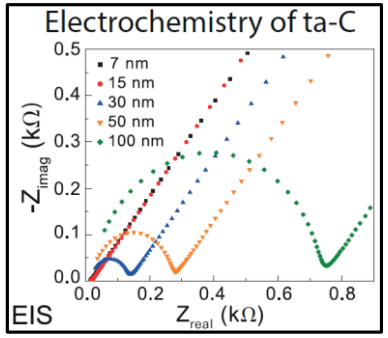
Computational studies



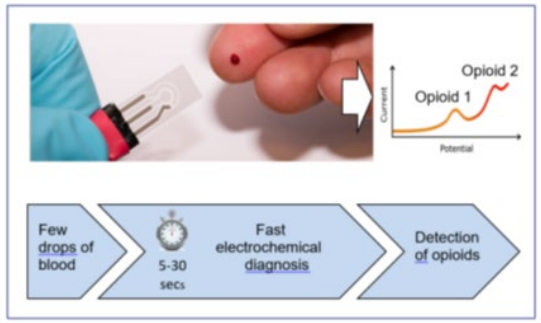
Bioelectronics

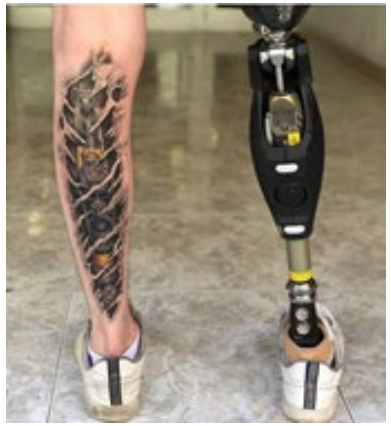


POC devices

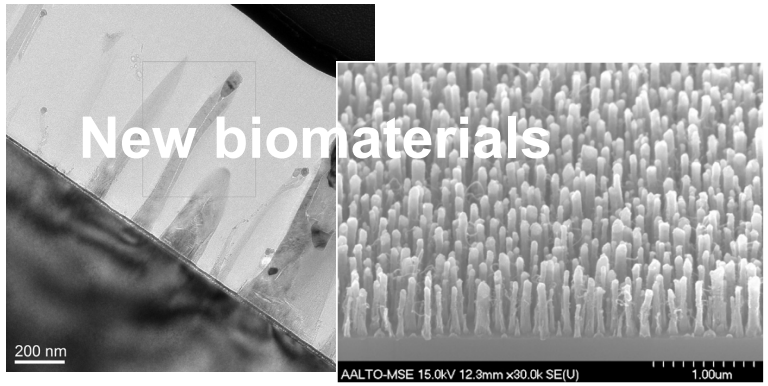


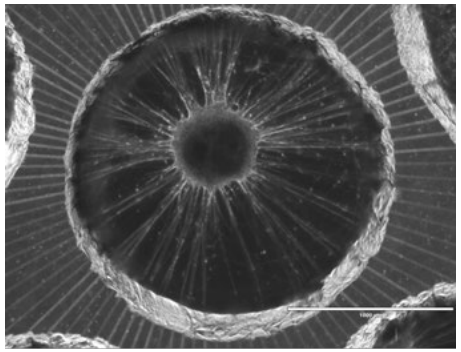
Electrochemistry

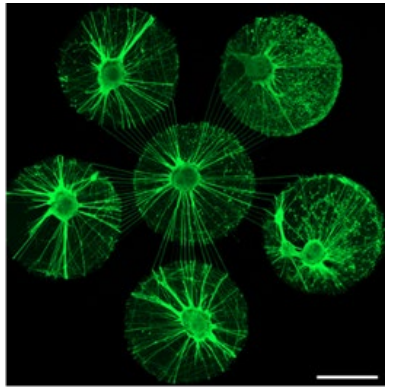


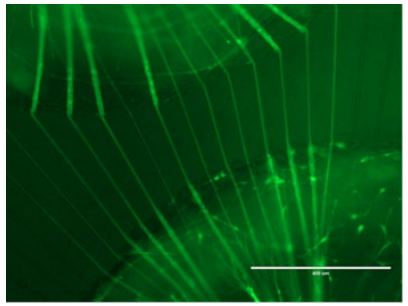


Biorobotics









Micro- and nanotechnology

Mandatory common courses of the programme (10 credits):			
JOIN-E3100	Life Science Technologies Project Course A	2	I/1
JOIN-E3200	Life Science Technologies Project Course B	8	III-V/1
Mandatory courses of the major (20 credits):			
ELEC-E8729	Biomaterial Interfaces	5	I-II/1
ELEC-E8726	Biosensing	5	III-IV/1
ELEC-E3260	Biomolecules	5	III/1
ELEC-E8734	Biomedical Instrumentation	5	II/1
Optional courses (25 credits):			
ELEC-E0210	Master's Thesis Process	2	I - summer
NBE-E4305	Biodesign–innovating medical technologies in multidisciplinary teams	5	V

3. Biomaterials and electrochemistry (Choose 25 cr)

ELEC-E8724	Biomaterials Science	5	I-II
ELEC-E8725	Methods of Bioadaptive Technology	5	I-II
CHEM-E4106	Electrochemistry P	5	III/1
CHEM-E4107	Laboratory Work in Electrochemistry	5	IV/1
CHEM-E4235	Transport Processes at Electrodes and Membranes	5	I-II/2
NBE-E4150	DNA Nanotechnology course	5	I-II

Modules:

1. Signal processing in biosciences (Choose 25 cr)

ELEC-C5212	Introduction to Statistical Signal Modelling	5	IV-V
ELEC-E8739	AI in health technologies	5	I-II
ELEC-E9111	Mathematical Computing	5	I-II
CS-E4710	Machine Learning: Supervised methods	5	I-II
ELEC-E7260	Machine Learning for Mobile and Pervasive Systems	5	III-IV
ELEC-E8743	Neurorobotics	5	III-IV

2. Micro- and nanofabrication (Choose 25 cr)

CHEM-E5115	Microfabrication	5	IV-V
CHEM-E8135	Microfluidics and BioMEMS	5	III-IV/1
ELEC-E3230	Nanotechnology	5	IV
ELEC-E3280	Micronova Laboratory Course	5	I-II
ELEC-E3220	Semiconductor Devices	5	III/1
NBE-E4150	DNA Nanotechnology course	5	I-II

Biosensing and –electronics

Recent MSc theses:

- Cell-free DNA extraction using bead-based microfluidics (2022)
- Screen-printed carbon electrode for electrochemical sensing of lactate from sweat (2022)
- Design and development of a medical device for automated ear inflammation recognition (2021)
- Evaluation of Regression Methods for Predicting Molecule Concentrations from Voltammetric Data (2020)
- Plug & Play Parameters for Patient Monitors (2020)
- Novel microfluidic perfusion chip for ex vivo brain slice imaging (2020)
- Effect of catalyst metal on the electrochemical properties on multi-walled carbon nanotubes (2020)

Recent PhD theses:

- Carbon nanostructures for neurotransmitter measurements (2017)
- Electrochemical techniques for glutamate measurement (2018)
- Electrochemistry of Amorphous Carbon-Based Materials - Development of an electrochemical sensor for the detection of dopamine (2019)
- Carbon-based hybrid nanomaterials for electrochemical detection of opioids (2021)
- Understanding the chemistry of carbonaceous substances for customized nanomaterials (2022)

Biosensing and –electronics

Job prospectives and postgraduate studies/academic career

- ✓ Many established large companies and a SME ecosystem
- ✓ Several recent start up's from the participating groups such as Synoste, Elsi Technologies (MariCare), RFSensIT etc.
- ✓ A lot of research collaboration with Universities across the globe

Tomi Laurila

Stephan Sigg

Ilkka Tittonen

Esa Ollila

Biosensing and – electronics

Katsuyuki Haneda

Markus Turunen

Ivan Vujaklija

Ilkka Laakso

Simo Särkkä

Aalto University
School of Chemical
Engineering

Master's Programme Life Science Technologies

Biosystems and Biomaterials Engineering Major

Prof. Alexander Frey

Knowledge & skills for addressing our most urgent challenges

Our current challenges are complex, and no simple solutions exist.

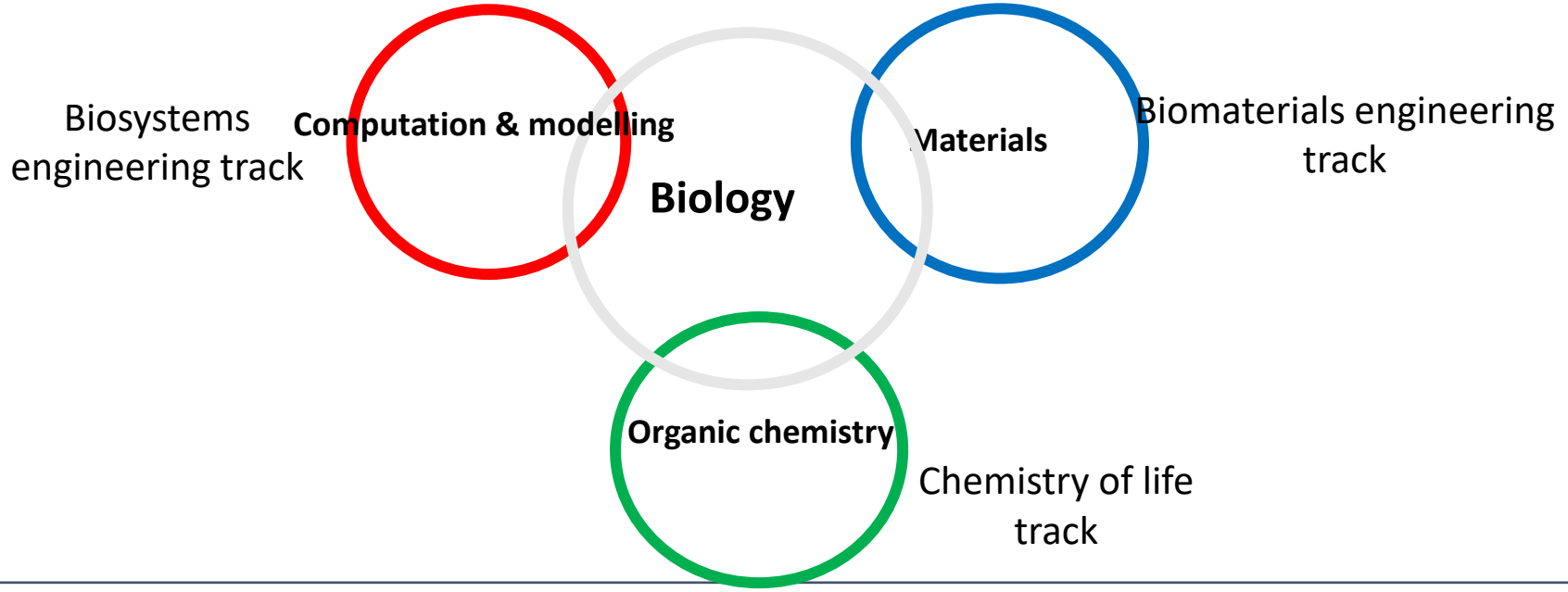
Biosystems and Biomaterials Engineering major provides you with the generic knowledge and skills that allows you addressing some of our most urgent challenges

https://sustainabledevelopment.un.org/sdgs

Biosystems and Biomaterials engineering Major

Complex problems require multidisciplinary approaches

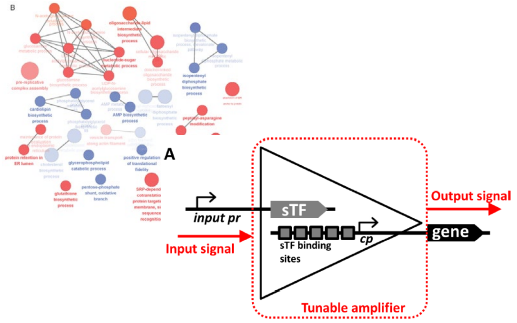
- Major comprises common compulsory studies of 30 ECTS and three distinctive tracks.



Biosystems and Biomaterials Engineering major

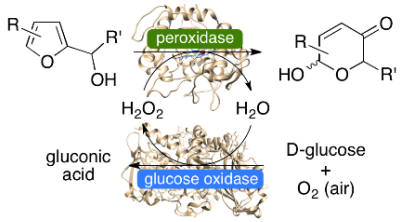
<u>Cellular systems</u> understanding at molecular and cellular level

- **Biosystems engineering**
  - biological data analysis
  - synthetic biology



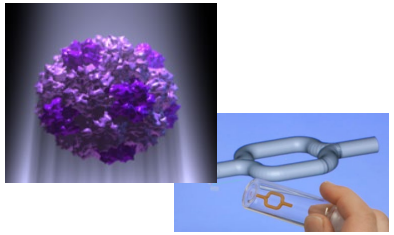
➢ Green chemistry

- **Chemistry of life**
  - Small organic molecules
  - Cells and enzymes as catalysts



➢ Energy

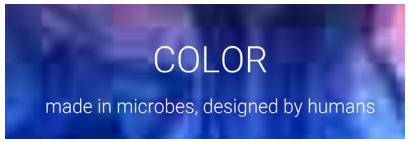
- **Biomaterials engineering**
  - synthetic and natural materials for medical applications



➢ Health

Future employment opportunities

Our graduates find employments in a broad range of functions & industries (Neste, Orion, Thermo, Terkko Health Hub, Blueprint genetics,…) and in research institutions (VTT, universities)

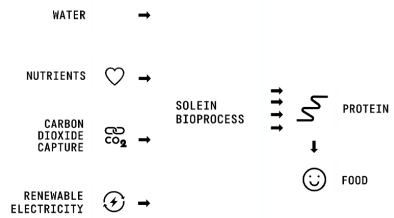


https://www.pili.bio/9/technology

FLORA-BASED, COW-FREE

We're doing this by creating milk proteins — casein and whey — that are nutritionally identical to what comes from a cow, but without animals.

https://www.perfectday.com



https://solarfoods.fi/

Animal-free egg white production is based on a safe, cost-efficient and environmentally sound technology called precision fermentation.

https://www.onego.bio/

https://boltthreads.com/technology/microsilk/