Open Research Day

9 April 2025

10:50-11:30

Parallel Sessions- *lightning talks followed by breakout session*

A108: AI for Environment

Chair: Professor Yifang Ban, KTH

A123: 6G – Communication, Sensing, Computing, Biology, Digitalized Medicine

Chair: Professor Emil Björnson, KTH

A123: 6G – Communication, Sensing, Computing, Biology, Digitalized Medicine

- Lightning talk: Session chair: Professor Emil Björnson, KTH

1. Emergence 2.0: Securing Edge Networks with a Programmable Intelligent Architecture (RP)
2. Demonstrating Rich and Batteryless Human-Powered Interaction using Backscatter Communication – HumanScatter (Demo)
3. Data-Limited Learning of Complex Dynamical Systems Data – Impact and Demonstrators (CI)
4. Large-scale delivery of an Internet-based psychological intervention in Region Stockholm using an advanced e-learning platform – QB-ACT (SI)
5. Models of non-normal and non-normative populations (Seed)

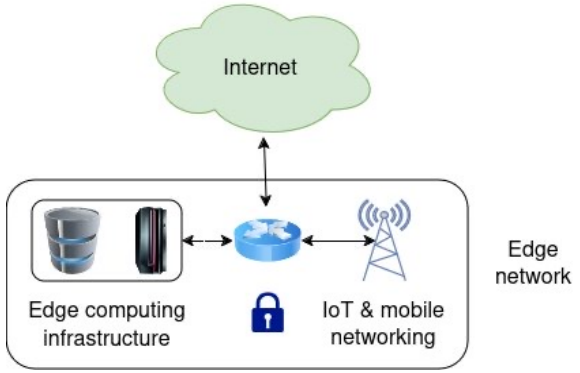
Emergence 2.0:
Securing Edge Networks with a Programmable Intelligent Architecture

Nicolas Tsiftes
Computer Science Department, RISE

Marco Chiesa
Software and Computer Systems, EECS, KTH

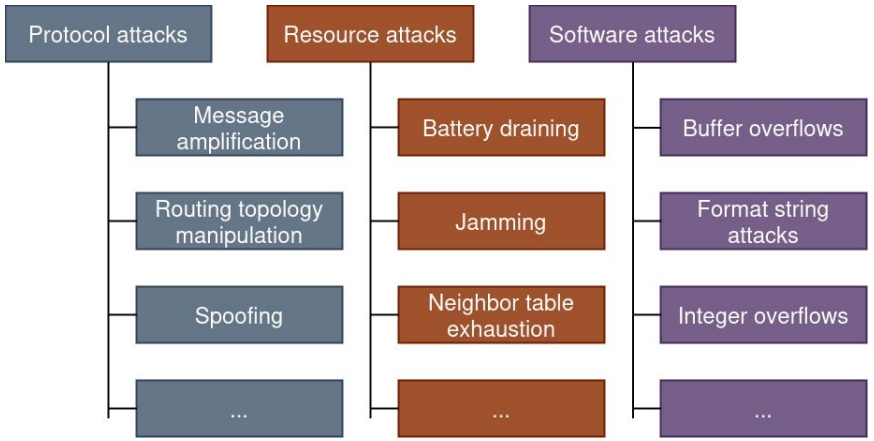
Securing Edge Networks

- Cyberattacks are a constant threat to the Internet
- Edge networks connect critical infrastructure that must be protected
- Real-time attack detection and prevention is needed



Challenges

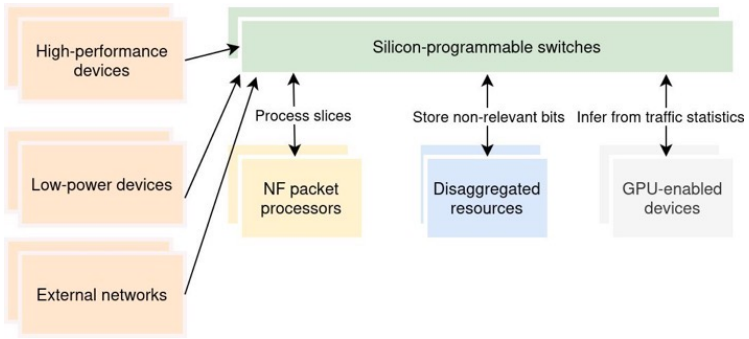
- Energy-efficient attack detection
  - Handle high volumes of traffic in high-speed networks
  - Efficiently gather traffic information for attack detection in IoT networks
- Different types of attacks
  - Stateful vs stateless
  - Software vulnerabilities, protocol vulnerabilities, misconfigurations



Categories of cyberattacks relevant for edge/IoT networks.

Emergence 2.0

- DF Research Pairs project
- Goal: Attack detection and policy enforcement for edge networks
- Focus on use cases
  - IoT network attacks
  - Internet misconfigurations



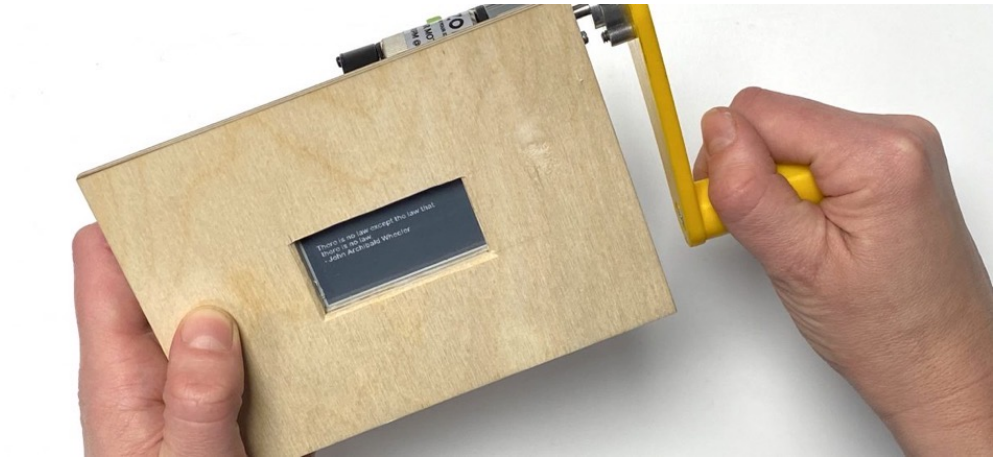
- Our architecture embraces *resource disaggregation* to process network traffic
  1. Offload complex logic to dedicated devices
  2. Slice-based packet processing
  3. Machine learning-accelerated traffic analysis

Thank you

HumanScatter

Demonstrating Rich and Batteryless Human-Powered Interaction using Backscatter Communication

Fehmi Ben Abdesslem
RISE Research Institutes of Sweden

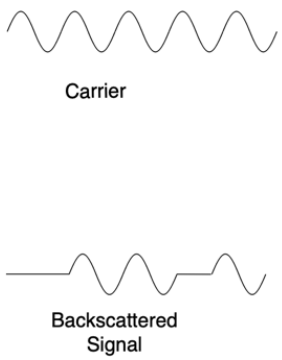


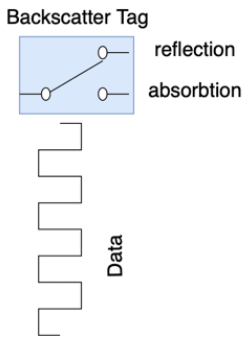
Human Power

- Cranking can deliver around 1 W
- Enough to power a microcontroller and transmit
- Available anywhere, anytime (almost!)

Backscatter

- Old principle: no need to transmit, reflecting is enough
- Saves a lot of energy
- Can be used to transmit sensor data





Human Power + Backscatter = HumanScatter

- We demonstrate both technologies with a prototype
- Harvesting data from low power sensors by cranking a box next to it

1. The box generates a carrier signal when cranking
2. The sensor reflects the signal to transmit data with only 8 mW instead of 65 mW
3. The box receives data and displays it

- All can be done without any battery!

Thank you

Data-Limited Learning of Complex Dynamical Systems (DLL) - Impact Project

David Broman
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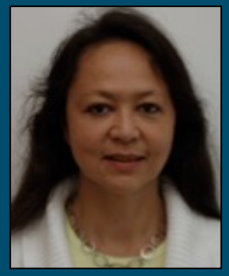
Division of Software and Computer Systems
EECS, KTH

Saikat Chatterjee
Associate Professor
Division of Information Science and Engineering
EECS, KTH



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Alexandre Proutiere
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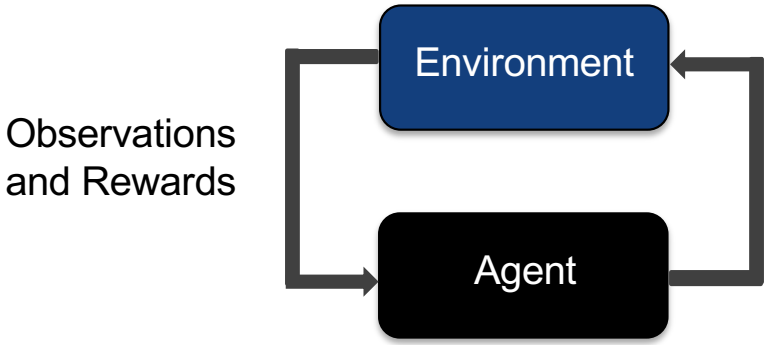
Research Challenge

Supervised Learning


Visual Object Recognition

Speech Recognition

Reinforcement Learning



Problems

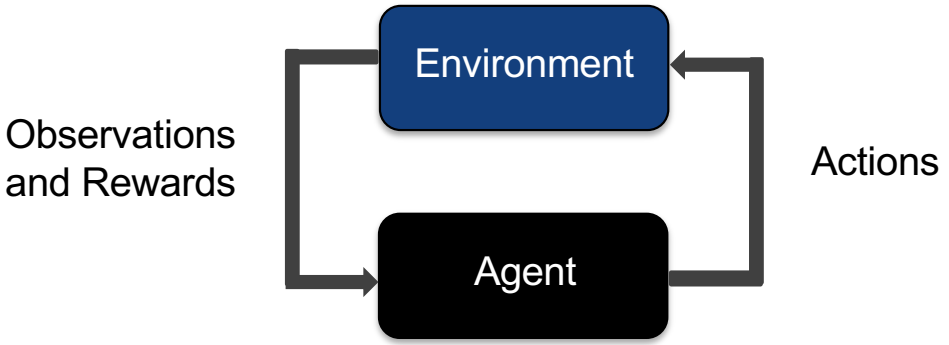
- Large amount of “free” data
- Known environment


Board and Video Games

Project Objectives

Research objective:

To develop new techniques, methods, and tools to learn to control ***complex dynamical systems*** *using a* ***limited number of data samples*** *and* ***structural information*** *in a reliable manner.*



Theory meets practice

Sub-project 1: Continuous bioprocessing

Sub-project 2: Reinforcement Learning in Cyber-Physical Systems (CPS)

Sub-project 3: Theory

CAD2REAL

- Learn to control real robots by training in simulation
- **State-of-the-art:**
  - Commercial off-the-shelf robots
  - Reinforcement Learning (RL)
- **Problem:** How to design a specially tailored robot?
- **Our approach:** Iterative co-design of
  - CAD
  - Automatic physical simulators
  - Physical system
  - Automatic RL policy

*image from https://www.hackster.io/

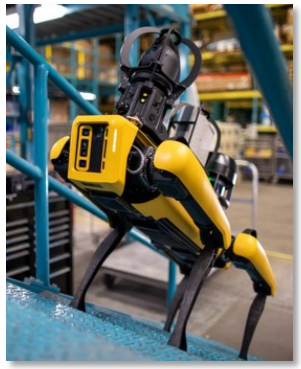
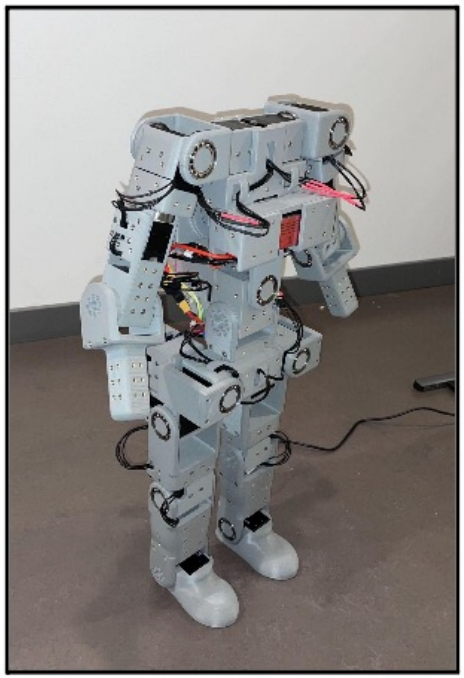
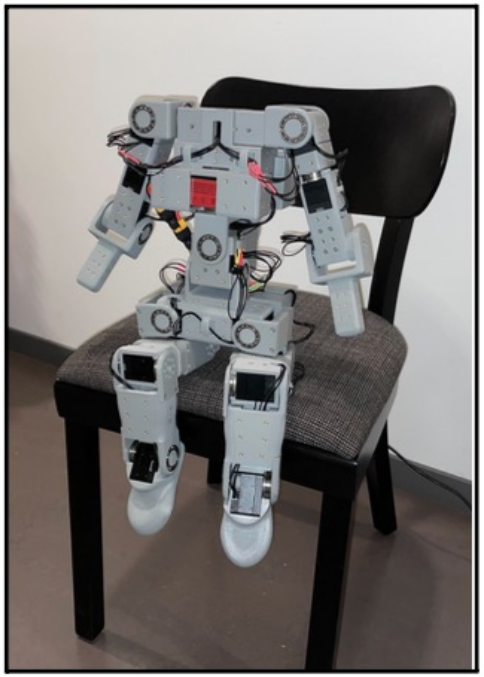


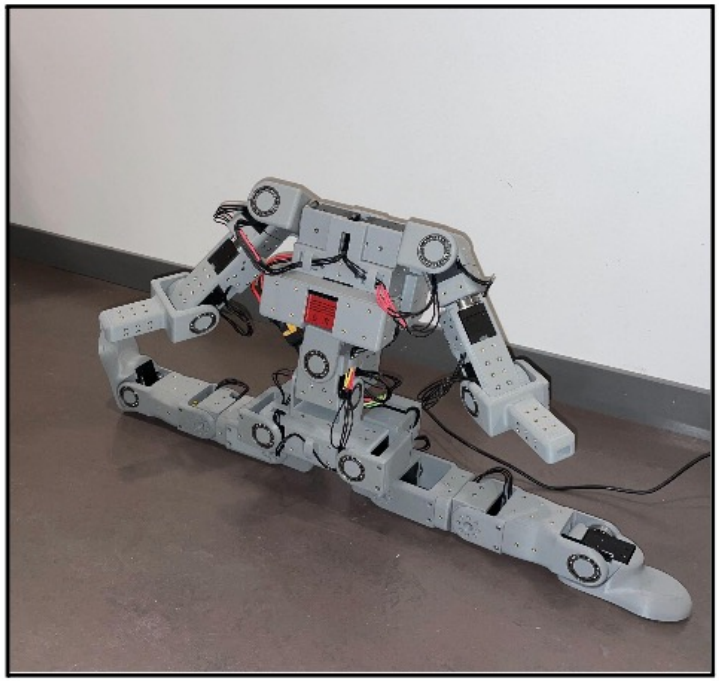
*image from https://bostondynamics.com/

*image from https://www.anybotics.com/

Demonstrations







Data-Limited Learning of Complex Dynamical Systems (DLL) - Impact Project

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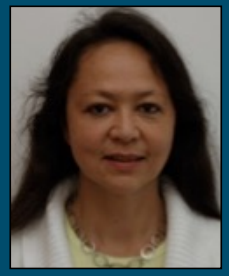

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Thank you

Psychological intervention using AI-generated e-learning - QB-ACT

Large-scale delivery of an Internet-based psychological intervention in Region Stockholm using an advanced e-learning platform

Olle Bälter
KTH EECS MID

Dagens Medicin

Psykiatri

Svårt få hjälp av psykiatrin

NYHET PUBLICERAT: 28 FEBRUARI, 2017 AV: ELSA PERSSON

Psykiatrispecialist: Öka antalet vårdplatser

Motion 2019/20:2927 av Camilla Waltersson Grönvall m.fl. (M)

Psykiatrin – korta köerna och stärk det förebyggande arbetet

AI-generated CBT course

- Effective learning: 50% reduction in learning time[1,2]
- Efficient course development: over 90% reduction in time[3,4]

1) *Lovett, Meyer & Thille, 2008: The Open Learning Initiative: Measuring the Effectiveness of the OLI Statistics Course in Accelerating Student Learning. Journal of Interactive Media in Education, 2008(1), 1–16.*
2) *O. Bälter , R. Glassey & M. Wiggberg (2021): Reduced learning time with maintained learning outcomes. SIGCSE '21: Proceedings of the 52nd ACM Technical Symposium on Computer Science Education March 2021 Pages 660– 665.*
3) *Bälter, O.; Glassey, R.; Jemstedt, A.; Bosk, D. Pure Question-Based Learning. Educ. Sci. 2024, 14, 882. https://doi.org/10.3390/educsci14080882*
4) *Jemstedt, A., Bälter, O., Gavel, A., Glassey, R., & Bosk, D. (2024). Less to produce and less to consume: the advantage of pure question-based learning. Interactive Learning Environments, 1–22.*

World-leading learning experience

Thank you

Statistical distribution of biological systems and the way forward

Models of non-normal and non-normative populations

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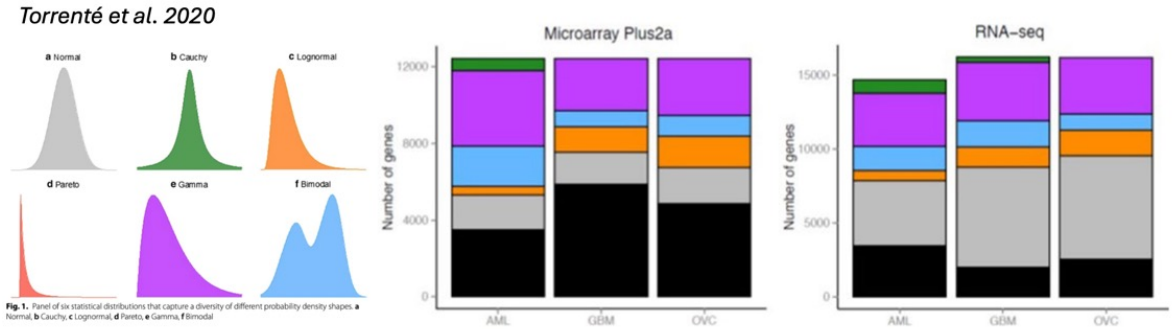
Arvind Kumar

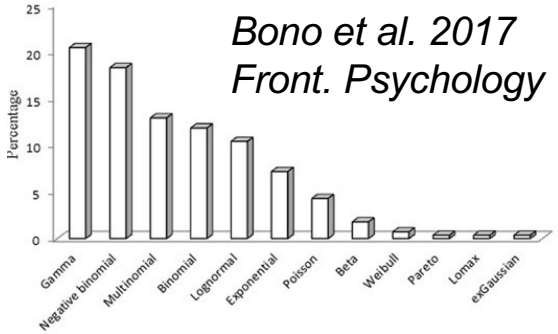
Lanie Guitierez-Farewick

Xiaogai Li

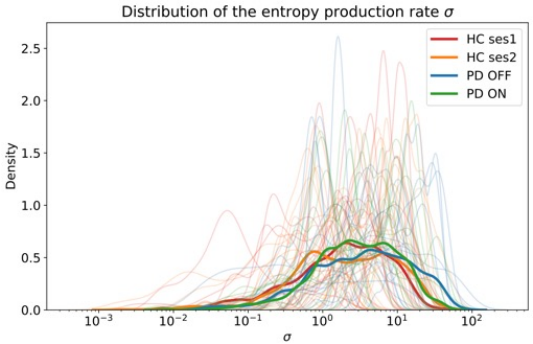
Normal distribution is not normal



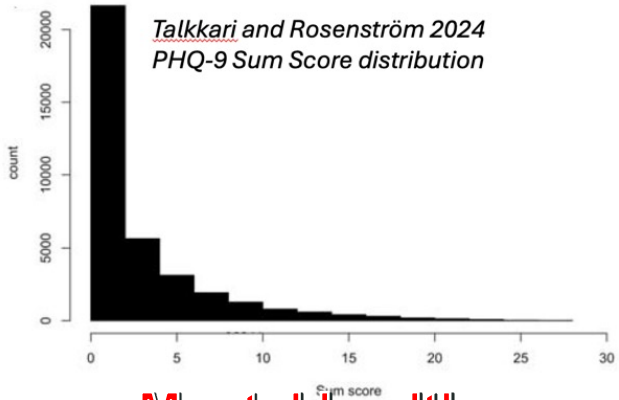
Gene expression



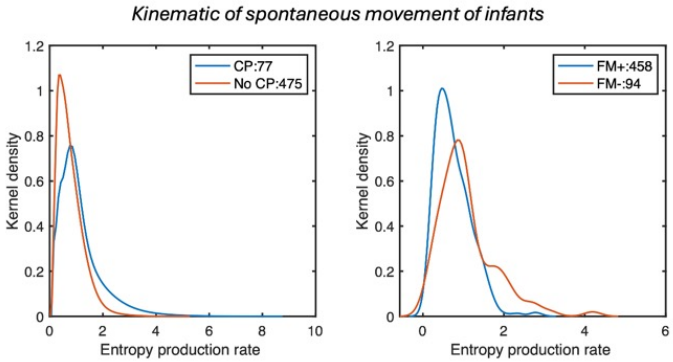
Health/education



Brain activity dynamics



Mental health



Movement kinematics

Origin and challenges of non-normal distributions in biological systems

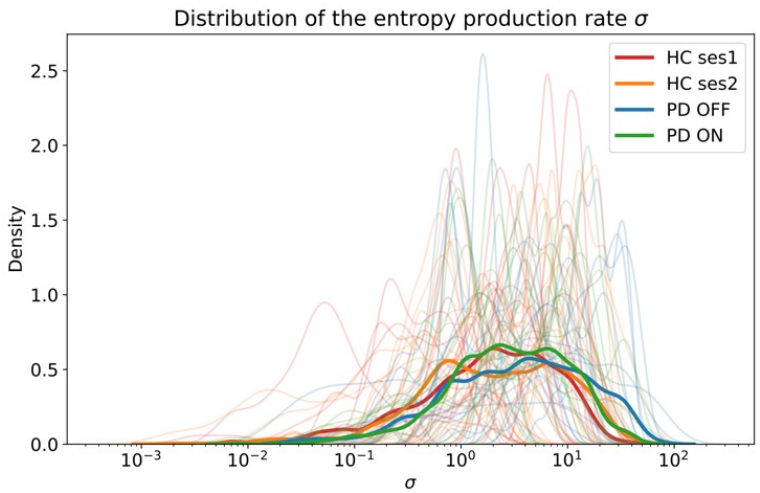
Origin

- Biological systems have multi-scale organization
- Most interactions are non-linear
- Biological systems adapt and compensate in their own respective environent
- Degeneracy: difference configutations of a system can lead to same output and vice versa

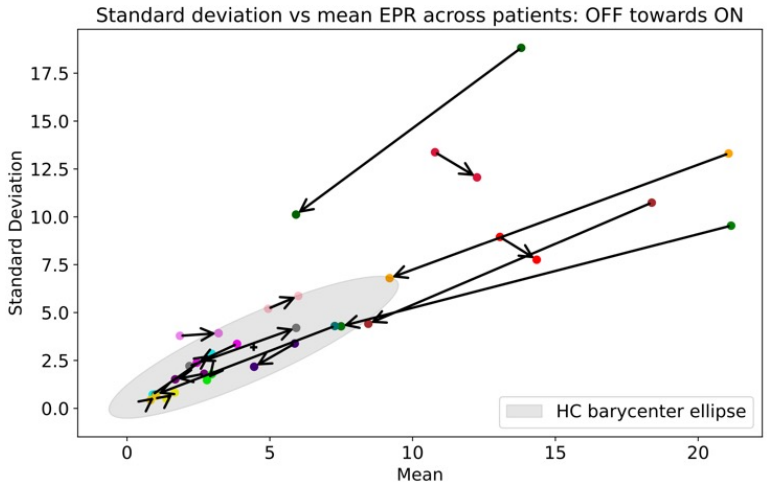
Challenge

- How to determine the biomarkers of the diseases
- Statistical testing become dodgy
- How to create models when population is composed of diverse individuals

The way forward: Personalized models



Entropy production rate distribution in healthy controls and Parkinson's Disease patients.



Comparison of a patients with its own medication on and off states makes sense

- Distribution of descriptors of biological systems are wide and heavy-tailed
- Patient distributions overlap with healthy controls – classification performance is poor

We can meaninfully only compare a person with itself, therefore

A good model of a person is a person, preferrably the same person

Thank you

digital futures

PARTNERS