NexTech Experts Panel II
Impending Technical Societal Challenges: Qvo Vadis?
(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NexTech 2021

IARIA

EXPERT PANEL

Impending Technical Societal Challenges: Qvo Vadis?

NexTech Experts Panel II

Impending Technical Societal Challenges: Qvo Vadis?
(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NexTech 2021

Facts

The speed of technological achievements, the diversity of services, and the complexity of systems/applications exceed by far the absorption power of our society concerning their adoption and use for everyone's benefit.

Challenges

- (too)Fast Changes in (tele)Communications
- Technical Illiteracy
- Protection of Information, sensing, tracking
- Cohabitation with machines
- Global health (care, pollution, containment)
- Adoption and Reluctance
- Digital Divide
- Accessibility, affordability, cooperation, inclusiveness
- Misinformation

NexTech Experts Panel II
Impending Technical Societal Challenges: Qvo Vadis?
(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NexTech 2021

Panelist Position

✓ **Chair**

➢ **Petre Dini**, IARIA, USA

✓ **Panelists**

➢ **Mihhail Matskin**, Royal Institute of Technology KTH, Sweden
➢ **Alireza Morsali**, McGill University, Canada
➢ **Anders Fongen**, Norwegian Defence University College, Norge
➢ **Michael Suppanz**, FH Kaernten, Austria
➢ **Efstratios Kontopoulos**, Catalink Limited, Cyprus
➢ **Christine Perakslis**, Arizona State University, USA

NexTech Experts Panel II

Impending Technical Societal Challenges: Qvo Vadis?
(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news,
social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NexTech 2021

IARIA

Panelist themes

- **Mihhail Matskin** Crowds of Mobile Wearable Devices

- **Alireza Morsali** Deep Learning Framework for Hybrid Analog-Digital Signal Processing in mmWave Massive-MIMO Systems

- **Anders Fongen** Detection of inauthentic profiles in social media through graph algorithms

- **Michael Alexander Suppanz** Knowledge, applicability, risks and potentials of AR / VR in the field of physiotherapy in Austria: results of an online survey

- **Efstratios (Stratos) Kontopoulos** Ethics and (Explainable) AI – Semantic AI & the Role of the Knowledge Scientist

- **Christine Perakslis** Resilience is essential for a robust society, yet society is operating within multiple converging contexts of digitization likely to lead to The Age of Allostatic Load (A-Load)

NexTech Experts Panel II

Impending Technical Societal Challenges: Qvo Vadis?

(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NexTech 2021

Panelist Position

A New Approach to Design and Interact with Systems and Applications

Petre Dini, IARIA, EU/USA petre@iaria.org

- AI/ML, DeepLearning, Cognition, Digital Twins, …

- 5G/6G, mmWave, Internet of Things (IoT), Drones, Network slicing, …

- Immersion, Virtual Reality, Social Networks, Self/Remote healthcare, …

- Miniaturization, software automation, robot-based critical services, …

→ Cognitive, adaptive, and user personalized interfaces

→ AI-based systems, Man-in-the-middle-systems, Reflexive systems (adaptable digital twins)

→ Humans - Machines Cohabitation
→ Knowledge Science!

NexTech Experts Panel II
Impending Technical Societal Challenges: Qvo Vadis?
(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NexTech
2021

Panellist Position

Note: # Crowds of Mobile Wearable Devices

Mihhail Matskin, *KTH, Sweden, misha@kth.se*

- Modern mobile wearable devices look like a collection of independent, opportunistic units, consuming data and information but not contributing to commonwealth or collaborative goals. However, they can be recruited to contribute to common goals and tasks.

- Wearable devices are equipped with a set of sensors and computational resources which are suitable for collecting data and for recognition of different situations. Instead of installing and maintaining a fixed (possibly expensive) sensory infrastructure for measuring the environmental or societal conditions we can utilize a flexible and dynamic crowds of wearables that are able to perform the tasks.

- A symbiosis of humans and wearable devices opens possibility to utilize the human body as receptors and actuators of wearables in cases when people find that this is beneficial for them.

NexTech Experts Panel II

Impending Technical Societal Challenges: Qvo Vadis?

(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NexTech 2021

Research Associate
Electrical and Computer Engineering Department
McGill University, Montreal, Canada

Deep Learning Framework for Hybrid Analog-Digital Signal Processing

in mmWave Massive-MIMO Systems

Dr. Alireza Morsali, McGill University, Montreal, Canada

alireza.morsali@mail.mcgill.ca

- AI for Wireless Communications
- Hybrid analog-digital signal processing
- mm-Wave Massive-MIMO for 5G and beyond
- Analog deep neural network (ADNN)
- Hybrid analog-digital deep neural network (HDNN)

NexTech Experts Panel II
Impending Technical Societal Challenges: Qvo Vadis?
(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NexTech
2021

Panellist Position

Detection of inauthentic profiles in social media through graph algorithms

Anders Fongen, Norway anders@fongen.no

- Presentation of student research on graph theory for detection of inauthentic algorithms

- Growing problems in social media, can even stir civil unrest

NexTech Experts Panel II

Impending Technical Societal Challenges: Qvo Vadis?

(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)
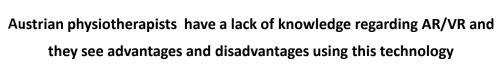
NexTech 2021

Dr. Michael Alexander Suppanz, MSc, MAS
Head of the degree program Physiotherapy at FH Kärnten (Austria)

Knowledge, applicability, risks and potentials of AR / VR in the field of physiotherapy in Austria: results of an online survey

- Use of augmented reality (AR) in physiotherapy yielded positive effects for example on balance, gait velocity,

    cadence, step length, …

- A crowd sourcing process tried to identify the knowledge applicability, risks and potentials of AR/VR with an online survey under austrian physiotherapists in 2020

- **Potential Benefits through AR/VR:**
    - ➢ increased motivation due to gaming aspects
    - ➢ development of new therapeutic approaches

- **Potential disadvantages through AR/VR:**
    - ➢ increased costs
    - ➢ a reduction of face to face contacts
    - ➢ increased risk to fall

- **Identified further interesting research topics :**
    - 🔍 the effect of AR on patients' adherence or compliance
    - 🔍 AR for diagnostics and therapy evaluation
    - 🔍 possible applications of AR in physiotherapy for specific pathologies

! **Austrian physiotherapists have a lack of knowledge regarding AR/VR and**

they see advantages and disadvantages using this technology

NexTech Experts Panel II
Impending Technical Societal Challenges: Qvo Vadis?
(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news,
social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

**NexTech
2021**

Panellist Position

Ethics and (Explainable) AI – Semantic AI & the Role of the Knowledge Scientist

Efstratios (Stratos) Kontopoulos, Knowledge Scientist, Catalink Ltd, Cyprus | e.kontopoulos@catalink.eu

- Skepticism against current AI solutions due to lack of Explainability → The Rise of XAI

- Emergence of Semantic AI & Role of Knowledge Graphs in XAI

- The Rising Role of the Knowledge Scientist

- Current SotA & Applications

→ Current widespread AI solutions work like black boxes and lack explanations for the generated inferences

→ End-users in various domains are skeptical towards AI-based systems

→ Semantic AI as a new paradigm for building AI solutions gives rise to a new role, i.e., the Knowledge Scientist

NexTech Experts Panel II

Impending Technical Societal Challenges: Qvo Vadis?

(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)
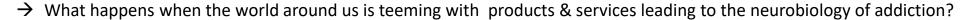
NexTech 2021

Resilience is essential for a robust society, yet society is operating within multiple converging contexts of digitization likely to lead to The Age of Allostatic Load (A-Load)

Converging Contexts & The Age of Allostatic Load

Christine Perakslis, Arizona State University, USA cperaksl@asu.edu

- Converging Contexts
    - Addiction by Design (Adb)
    - Convergence of Digitization
    - Societal VUCA (Volatility, Uncertainty, Complexity, and Ambiguity)
    - Covid Consequences

- The Age of Allostatic Load (A-Load)

➔ What happens when the world around us is teeming with products & services leading to the neurobiology of addiction?

➔ What happens when there is a convergence of contexts leading to the neurobiology of stress?

➔ Are we entering the Age of A-Load?

NexTech Experts Panel II
Impending Technical Societal Challenges: Qvo Vadis?
(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NexTech
2021

Panellist Position

Crowds of Mobile Wearable Devices

Mihhail Matskin, *KTH, Sweden, misha@kth.se*

Contributors: Petar Mrazovic, Ville Granfors, Johan Waller, Valeriya Kutasarova, Justas Dautaras,

Mihhail Matskin

- Professional experience
  - Professor of Software Engineering at Royal Institute of Technology (KTH) , Sweden(2002 – now)
  - Assoc. Professor and Professor at Norwegian University of Science and Technology (NTNU), Trondheim, Norway (1995-2002)
  - Researcher, leading researcher, Head of department, Institute of Cybernetics, Estonian Academy of Science, Tallinn, Estonia (1977-1995)

- Main projects
  - EU HORZON2020 (EDSA, DataCloud)
  - EU EIT Digital
  - EU FP7 (SmartMuseum)
  - EU FP6 (Roboswarm)
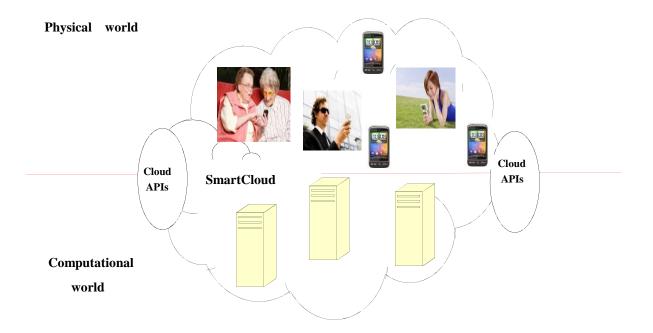
- Awards
  - Best paper awards ICIW, SEMAPRO
  - Best runner paper up award ICWS
  - Soviet State Prize in Software Engineering
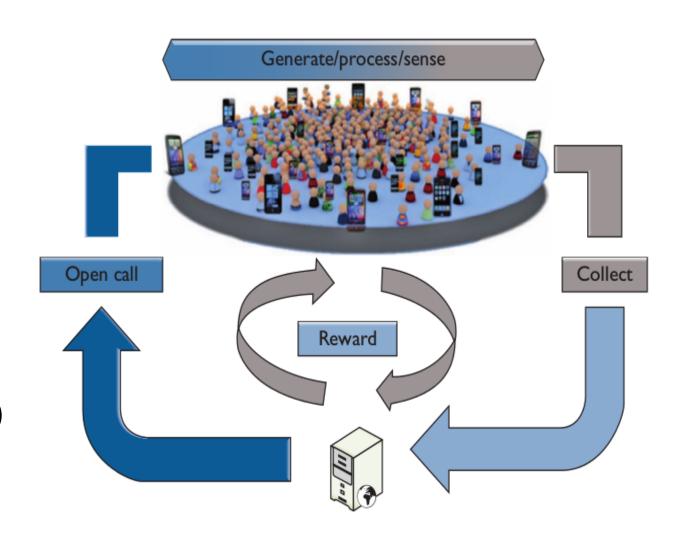
People with wearable devices are everywhere

- People with connected wearable devices are nowadays available in almost every corner of the world

- Modern wearable devices are equipped with a large spectrum of sensors and computational resources which are suitable for collecting data and for recognition of different situations.

Physical world

Cloud APIs

SmartCloud

Cloud APIs

Computational world

Wearable devices vs. fixed sensory infrastructure
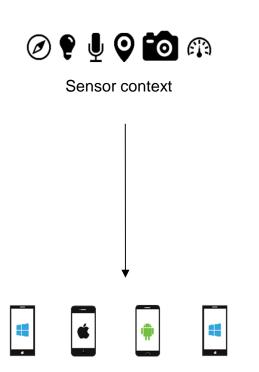
- **Limitation:** Modern mobile wearable devices look like a collection of independent, opportunistic units, consuming data and information but not contributing to commonwealth or collaborative goals.

- **Problem:** How can wearables devices be recruited to contribute to common goals and tasks?

- **A Solution:** Instead of installing and maintaining a fixed (possibly expensive) sensory infrastructure for measuring the environmental or societal conditions we can utilize a flexible and dynamic crowds of wearables.
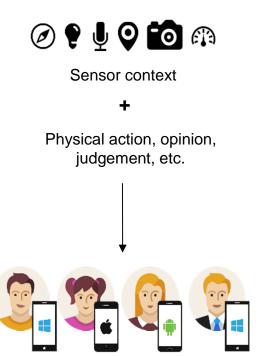
Crowds of wearable devices

- Humans are carriers of wearables

- A symbiosis of humans and devices opens possibility to utilize the human body as receptors and actuators of devices when people find that this is beneficial for them.
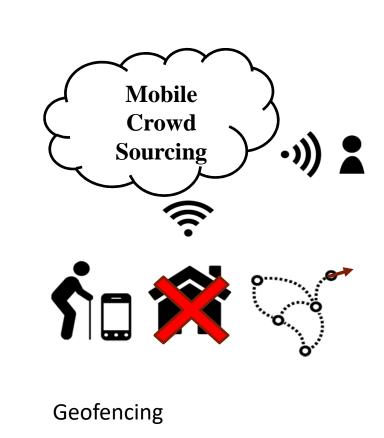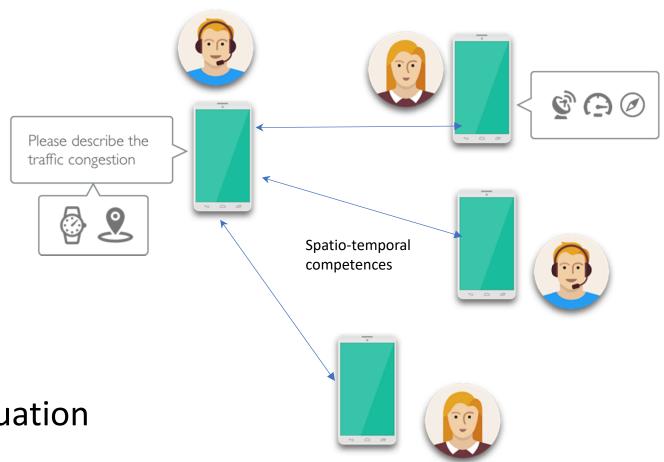
Sensor context

Sensor context

+

Physical action, opinion, judgement, etc.

Applications: Managing Alarming Situations

Elderly people monitoring

Community support

Geofencing

Application: Environmental monitoring

- Monitoring environmental characteristics:
  - air quality
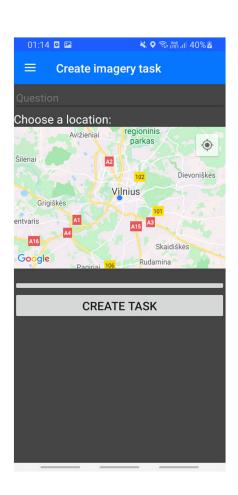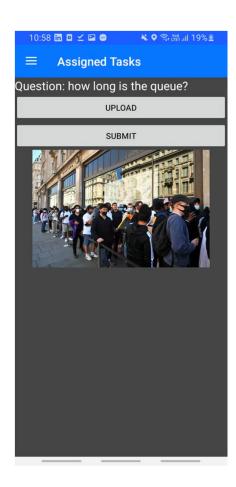 - noise level
  - radiation level
  - pollen level

...

- Evaluation of transport situation

Applications: Visual crowdsensing

Thank you!

- More to read:
  - V Kutsarova, M Matskin. Combining Mobile Crowdsensing and Wearable Devices for Managing Alarming Situations, 2021 IEEE Annual Computers, Software, and Applications Conference (COMPSAC), 2021
  - V. Granfors, J. Waller, P. Mrazovic, and M. Matskin, "CrowdS: Crowdsourcing with Smart Devices", in Internet Computing & Internet of Things, 2018 International Conference on, CSCE
  - Ozlem Zehra Ozyagci and Mihhail Matskin. **"Truthful Incentive Mechanism for Mobile Crowdsensing with Smart Consumer Devices"**. In Proc: 4th IEEE International Workshop on Consumer Devices and Systems (CDS 2016), COMPSAC 2016 Workshops, Atlanta, USA, 2016
  - Petar Mrazovic,Mihhail Matskin, Nima Dokoohaki. Trajectory-Based Task Allocation for Reliable Mobile Crowd Sensing Systems. Workshop at ICDM2015, Atlantic City, USA, November 14-17, 2015
  - Petar Mrazovic, Mihhail Matskin.MobiCS: Mobile Platform for Combining Crowdsourcing and Participatory Sensing. 2015 IEEE 39th Annual International Computers, Software & Applications Conference (COMPSAC2015), IEEE Computer Society, Taichung, Taiwan, July 1-5, 2015, 553-562

IARIA

NextTech Experts Panel II
Impending Technical Societal Challenges: Qvo Vadis?
(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NextTech 2021

Deep Learning Framework for Hybrid Analog-Digital Signal Processing in mmWave Massive-MIMO Systems

Alireza Morsali

Research Associate
Department of Electrical and Computer Engineering
McGill University, Montreal

October, 2021

Introduction

Systems and Problem Formulation

Hybrid Analog Digital Deep neural Networks
    Analog Linear Module
    RF nonabrasive
    Hybrid DNN

Simulation Results and Conclusion

Outline

Introduction

Systems and Problem Formulation

Hybrid Analog Digital Deep neural Networks
    Analog Linear Module
    RF nonabrasive
    Hybrid DNN

Simulation Results and Conclusion

Advent of Massive-MIMO

▶ Multiple-input-multiple-output (MIMO) is a revolutionary and essential technique for modern wireless systems (4G, LTE, LTE-A, ...)

▶ Massive-MIMO for 5G and beyond 5G networks
  • Reduce latency
  • Increase the capacity
  • Improve the radiated energy-efficiency

▶ Massive-MIMO becomes possible by
  • Advances in mmWave (30-100 GHz) Communication

  • Development of low-power RF components
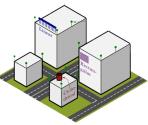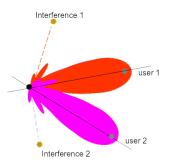
  • Hybrid analog and digital design
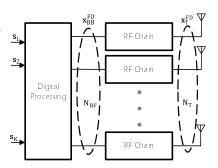
Figure: [Larsson et al., 2014]

Beamforming in mmWave Massive-MIMO

- ▶ Increase coverage
  - By increasing system capacity

- ▶ Improve signal quality
  - By interference rejection

- ▶ Reduce latency
  - By suppressing delay spread

- ▶ Save energy
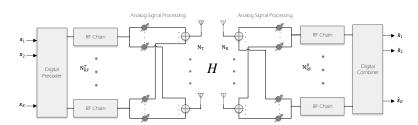 - By improving the radiated energy efficiency

Beamforming Challenge in Massive-MIMO

▶ Fully-digital (FD) structure requires one RF chain per antenna element

▶ Large number of RF chains
  • High price
  • High power consumption
  • Complicated hardware design

▶ Implementation of fully-digital structure is inefficient

Outline
○

Introduction
○○○○●

System Model
○○○○○

Hybrid DNN
○○○○○○○○○

Results
○○○○○○○

Hybrid Analog Digital Beamforming

▶ Hybrid Beamforming (HBF) is the solution
  • By introducing an extra layer of analog signal processing
  • The number of required RF chains can be reduced

Massive-MIMO Transceiver with Hybrid Analog/Digital Structure
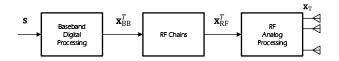
Outline

Generalized hybrid analog/digital transmitter

- Let us consider a massive-MIMO BS with N_T antennas and N_{RF}^T RF chains
- Vector $\mathbf{s} \in \mathscr{A}^{N_s}$ first goes through digital signal processing (DSP)

$$\mathbf{x}_{\mathrm{BB}}^{\mathrm{T}} = \mathscr{F}_T(\mathbf{s}) \in \mathbb{C}^{N_{RF}^T} \tag{1}$$

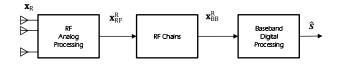where $\mathscr{F}_T : \mathscr{A}^{N_s} \to \mathbb{C}^{N_{RF}^T}$ is a mapping

- Then, N_{RF}^T RF chains convert $\mathbf{x}_{\mathrm{BB}}^{\mathrm{T}}$ into the bandpass signal $\mathbf{x}_{\mathrm{RF}}^{\mathrm{T}}$
- The latter is next fed to the analog signal processing (ASP) module which consists of simple RF circuitry
- $\mathbf{x}_{\mathrm{T}}$ is then transmitted by means of an antenna array

$$\mathbf{x}_{\mathrm{T}} = \sqrt{\rho}\mathscr{G}_T(\mathbf{x}_{\mathrm{RF}}^{\mathrm{T}}) \in \mathbb{C}^{N_T} \tag{2}$$

where $\mathscr{G}_T : \mathbb{C}^{N_{RF}^T} \to \mathbb{C}^{N_T}$ maps the RF vector $\mathbf{x}_{\mathrm{RF}}^{\mathrm{T}}$ to transmitted signal $\mathbf{x}_{\mathrm{T}}$

Generalized hybrid analog/digital receiver

▶ At a receiver with N_R antennas and N_{RF}^R RF chains, $\mathbf{x}_R$ is first processed by the ASP as follows:
$$\mathbf{x}_{RF}^R = \mathscr{G}_R(\mathbf{x}_R) \in \mathbb{C}^{N_{RF}^R}, \qquad (3)$$

for $\mathscr{G}_R : \mathbb{C}^{N_R} \to \mathbb{C}^{N_{RF}^R}$

▶ The RF signal $\mathbf{x}_{RF}^R$ is next converted to baseband digital vector $\mathbf{x}_{BB}^R$ by means of N_{RF}^R RF chains

▶ Finally, $\mathbf{x}_{BB}^R$ is given to the DSP module to obtain the decoded symbols

$$\hat{\mathbf{s}} = \mathscr{F}_R(\mathbf{x}_{BB}^R) \qquad (4)$$

where $\mathscr{F}_R : \mathbb{C}^{N_{RF}^R} \to \mathscr{A}^{N_s}$

Deep Neural Networks

▶ Multi-layer perceptron (MLP), or artificial neural network, with one hidden layer, d neurons and a set of parameters $\boldsymbol{\theta}$ is given by:

$$\Gamma(\mathbf{x}; \boldsymbol{\theta}) = \mathbf{W}\, \psi_d(\mathscr{A}(\mathbf{x})), \qquad (5)$$

where $\mathbf{x} \in \mathbb{C}^n$ is the input vector, $\mathscr{A}(\mathbf{x}) : \mathbb{C}^n \to \mathbb{C}^d$ is an affine transformation, ψ_d is a non-linear activation function and $\mathbf{W} \in \mathbb{C}^{m \times d}$ is the weight matrix of the output layer.

▶ A DNN comprised of $L \in \mathbb{N}$ hidden layers indexed by $l \in \{1, 2, \ldots, L\}$, $n_l \in \mathbb{N}$ neurons at the l-th hidden layer, and one output layer indexed by $l = L + 1$, with input vector $\mathbf{x} \in \mathbb{C}^{N_0}$ and output vector $\mathbf{y} \in \mathbb{C}^{n_{L+1}}$:

$$\mathbf{y} = \Omega(\mathbf{x}; \boldsymbol{\theta}) = (\mathscr{A}_{L+1} \circ \psi_{n_L} \circ \mathscr{A}_L \circ \cdots \circ \psi_{n_1} \circ \mathscr{A}_1)(\mathbf{x}) \qquad (6)$$

where $\mathscr{A}_l : \mathbb{C}^{n_{l-1}} \to \mathbb{C}^{n_l}$ is the affine transformation used at the l-th layer, i.e., $\mathscr{A}_l(\mathbf{x}) = \mathbf{A}_l \mathbf{x} + \mathbf{b}_l$, with $\mathbf{A}_l \in \mathbb{C}^{n_l \times n_{l-1}}$, $\mathbf{b}_l \in \mathbb{C}^{n_l}$ representing the weights and biases of the l-th layer

▶ The ordered set of all parameters characterizing the DNN can be written as $\boldsymbol{\theta} = \{\mathbf{A}_1, \mathbf{b}_1, \mathbf{A}_2, \mathbf{b}_2, \ldots, \mathbf{A}_{L+1}, \mathbf{b}_{L+1}\}$

► We can replace the baseband beamforming at the transmitter with

$$\mathscr{F}_T(\mathbf{s}) = \Omega_T^D(\mathbf{s}; \boldsymbol{\theta}_T^D), \tag{7}$$

where $\boldsymbol{\theta}_T^D$ is the parameter set of this *digital* DNN.

► Subsequently, the analog bemforming with

$$\mathscr{G}_T(\mathbf{x}_{\mathrm{RF}}) = \Omega_T^A(\mathbf{x}_{\mathrm{RF}}; \boldsymbol{\theta}_T^A), \tag{8}$$

where $\boldsymbol{\theta}_T^A$ is the parameter set of the ADNN.

► By concatenating the above DNNs, we can write the transmitted signal as:

$$\mathbf{x}_{\mathrm{T}} = \Omega_T^H(\mathbf{s}; \boldsymbol{\theta}_T), \tag{9}$$

where $\boldsymbol{\theta}_T = \{\boldsymbol{\theta}_T^A, \boldsymbol{\theta}_T^D\}$ is the composite parameter set of the resulting downlink HDNN..

► Similarly, in the downlink case, we can write

$$\hat{\mathbf{s}} = \Omega_R^H(\mathbf{y}; \boldsymbol{\theta}_R) = \Omega_R^A\Big(\big(\Omega_R^D(\mathbf{y}; \boldsymbol{\theta}_R^D)\big); \boldsymbol{\theta}_R^A\Big), \tag{10}$$

where $\boldsymbol{\theta}_R$ is the parameter set of the resulting uplink HDNN

Outline
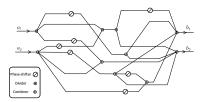
Introduction

Systems and Problem Formulation

Hybrid Analog Digital Deep neural Networks
   Analog Linear Module
   RF nonabrasive
   Hybrid DNN

Simulation Results and Conclusion

Outline	Introduction	System Model	Hybrid DNN	Results
O	OOOOO	OOOOO	OOOOOOOOO	OOOOOOO

Analog Linear Module

Outline	Introduction	System Model	Hybrid DNN	Results
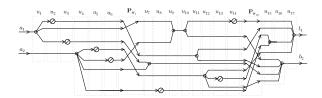
Analog Linear Module

Intuition: Linear RF Module

To illustrate the application of this result, consider the following ASP network

This network can be reorganized as a product of basic RF transformations as follows

Outline	Introduction	System Model	**Hybrid DNN**	Results
○	○○○○○	○○○○○	○○○●○○○○○	○○○○○○○

Analog Linear Module

Theorem

Any ASP network with M input ports and N output ports implemented by arbitrary number of phase-shifters, power dividers and power combiners, can be modeled as:
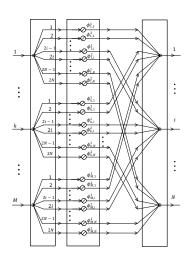
$$\mathbf{b} = \frac{1}{\sqrt{MN}} \mathbf{A} \mathbf{a} \tag{11a}$$

$$\mathbf{A} \in \breve{\mathbb{U}}^{N \times M} \tag{11b}$$

where $\mathbf{a} \in \mathbb{C}^M$ and $\mathbf{b} \in \mathbb{C}^N$ are input and output signals, respectively and $\breve{\mathbb{U}} = \{z \in \mathbb{C} : |z| \leq 1\}$

Theorem

Any given matrix $\mathbf{A} \in \breve{\mathbb{U}}^{N \times M}$ can be realized by an ASP network with a total number of $T = 2MN + M + N$ RF components, i.e., N dividers, M combiners, and $2NM$ (unit-modulus) phase shifters

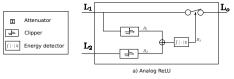[Morsali et al., 2020]:A. Morsali, A. Haghighat and B. Champagne, "Generalized framework for hybrid analog/digital signal processing in massive and ultra-massive-MIMO Systems," *IEEE Access*, vol. 8, pp. 100262–100279, 2020.
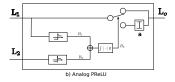
Introduction

Systems and Problem Formulation

Hybrid Analog Digital Deep neural Networks
  Analog Linear Module
  RF nonabrasive
  Hybrid DNN

Simulation Results and Conclusion

Outline	Introduction	System Model	Hybrid DNN	Results
O	ooooo	ooooo	ooooo●ooo	ooooooo

RF nonabrasive

Analog ReLU

a) Analog ReLU   b) Analog PReLU

▶ Rectified linear unit (ReLU) and Parametrtic ReLU (PReLU) activation functions:

$$\text{ReLU}(x) = x^+ = \max(0, x), \quad x \in \mathbb{R} \qquad (12)$$

$$\text{PReLU}(x) = \begin{cases} ax & \text{if } x < 0 \\ x & \text{if } x \geq 0 \end{cases} \qquad (13)$$

▶ The modulated signal is fed to L_1 and the carrier is fed to L_2 as a reference. The output L_o is equal to the input signal L_1 when the baseband signal is positive and zero otherwise

▶ When the modulated signal L_1 and the carrier L_2 are in phase, corresponding to a positive value of the baseband component, B_1 and B_2 are equal and the energy of their sum is non-zero

▶ Consequently, the output of the energy detector $B_3 = 1$ which can be used to activate (i.e., close) the switch

▶ When the modulated signal L_1 and the carrier L_2 are out of phase (corresponding to a negative value of the baseband component), we have $B_2 = -B_1$

▶ Consequently, the energy of their sum is zero and the output of energy detector $B_3 = 0$, which opens the switch

Outline	Introduction	System Model	Hybrid DNN	Results
○	○○○○○	○○○○○	○○○○○○○●○	○○○○○○○

Hybrid DNN

Analog MLP
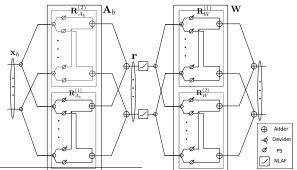
Theorem 1

A given MLP $\Gamma(\boldsymbol{x}; \boldsymbol{\theta})$ with one hidden layer and non-linear activation function $\psi_d()$ (either ReLU or PReLU) can be realized by the RF structure shown in Figer below.

A. Morsali, A. Haghighat and B. Champagne, "Deep learning framework for hybrid analog-digital signal processing in mmWave massive-MIMO systems," Preprint available at: https://arxiv.org/abs/2107.14704

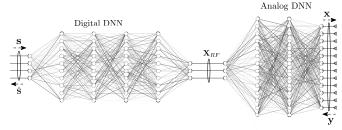| Outline	Introduction	System Model	Hybrid DNN	Results
○	○○○○○	○○○○○	○○○○○○○○●	○○○○○○○

Hybrid DNN

Hybrid DNN

Digital DNN

Analog DNN

$\mathbf{X}_{RF}$

▶ The HDNN can be trained to learn an arbitrary transmission scheme, as defined by the mappings $\mathscr{F}_T(\cdot)$ and $\mathscr{G}_T(\cdot)$.

$$L(\boldsymbol{\theta}_T) = \left\| \Omega_T^H(\mathbf{s}; \boldsymbol{\theta}_T) - \mathscr{G}_T \circ \mathscr{F}_T(\mathbf{s}) \right\|_2. \tag{14}$$

▶ Used for non-linear beamforming technique such as vector perturbation, Tomlinson-Harashima precoding, robust beamformer design under imperfect CSI, and space-time coding.

▶ It is possible to let the transmitter learn the optimal transmission scheme without explicitly specifying its structure *a priori*

▶ For instance, in the case of a massive-MIMO BS with a single UE, and assuming that the latter UE uses a fixed combiner matrix $\mathbf{C}$ known at the transmitter side, the HDNN can be trained using,

$$L(\boldsymbol{\theta}_T) = \left\| \mathbf{C} \, \mathbf{H}_D \, \Omega_T^H(\mathbf{s}; \boldsymbol{\theta}_T) - \mathbf{s} \right\|_2. \tag{15}$$

Outline

Methodology

▶ We use the following mmWave massive-MIMO channel model [Sohrabi and Yu, 2016, Lin et al., 2019],

$$\mathbf{H} = \sqrt{\frac{N_T M}{N_c N_{\mathrm{ray}}}} \sum_{i=1}^{N_c} \sum_{j=1}^{N_{\mathrm{ray}}} \alpha_{ij} \mathbf{a}_{\mathrm{r}}(\theta_{ij}^{\mathrm{r}}) \mathbf{a}_{\mathrm{t}}(\theta_{ij}^{\mathrm{t}})^H, \tag{16}$$

where $N_c = 5$ is the number of clusters, and $N_{\mathrm{ray}} = 10$ is the number of rays in each cluster
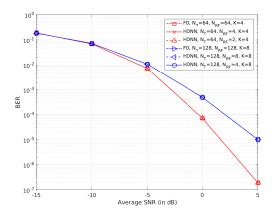
▶ Similar to [Sohrabi and Yu, 2016, Lin et al., 2019], the path gains are independently generated as $\alpha_{ij} \sim \mathcal{CN}(0, 1)$. The transmit and receive antenna responses are denoted by $\mathbf{a}_{\mathrm{r}}(\theta_{ij}^{\mathrm{r}})$ and $\mathbf{a}_{\mathrm{t}}(\theta_{ij}^{\mathrm{t}})$ respectively

▶ For simplicity, a uniform linear array of size N with half-wavelength spacing is employed, hence where,

$$\mathbf{a}(\phi) = \frac{1}{\sqrt{N}}[1, e^{j\pi \sin(\phi)}, \ldots, e^{j(N-1)\pi \sin(\phi)}] \tag{17}$$

The angles of arrival θ_{ij}^{r} and departure θ_{ij}^{t} are independently generated according to the Laplacian distribution with mean cluster angles $\bar{\theta}_{ij}^{\mathrm{r}}$ and $\bar{\theta}_{ij}^{\mathrm{t}}$, uniformly distributed in $[0, 2\pi]$, while the angular spread is set to 10 degrees within each cluster.

Simulation Results
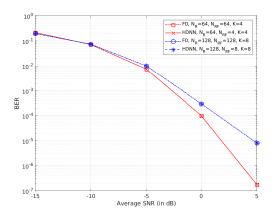
BER versus SNR of proposed HDNN designs and FD beamforming for downlink connection of 64×4 and 128×8 systems.

Simulation Results

BER versus SNR of proposed HDNN designs and FD beamforming for uplink connection of 64×4 and 128×8 systems

Summary

► overview of massive-MIMO and Hybrid beamforming

► Generalized system formulation and problem statement

► A general DL framework for efficient design and implementation of HBF in massive-MIMO systems

► Linear and non-linear modules in RF domain

► Analog MLP and deep neural networks

► The proposed HDNN architecture enables HBF-based massive-MIMO transceivers to approximate any desired transmitter and receiver mapping with arbitrary precision

► We are able to present a new HDNN-based beamformer design that can achieve the same performance as FD beamforming, with reduced number of RF chains

References I

Larsson, E. G., Edfors, O., Tufvesson, F., and Marzetta, T. L. (2014).
Massive mimo for next generation wireless systems.
IEEE Communications Magazine, 52(2):186–195.

Lin, T., Cong, J., Zhu, Y., Zhang, J., and Letaief, K. B. (2019).
Hybrid beamforming for millimeter wave systems using the mmse criterion.
pages 1–1.

Morsali, A., Haghighat, A., and Champagne, B. (2020).
Generalized framework for hybrid analog/digital signal processing in massive and ultra-massive-MIMO systems.
IEEE Access, 8:100262–100279.

Sohrabi, F. and Yu, W. (2016).
Hybrid digital and analog beamforming design for large-scale antenna arrays.
10(3):501–513.

Thank you very much

NextTech Experts Panel II

Impending Technical Societal Challenges: Qvo Vadis?

tization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)

NextTech 2021

Panellist Position

Detection of inauthentic profiles in social media through graph algorithms

Anders Fongen, Norway

anders@fongen.no

Norwegian Defence Military University

- Presentation of student research on graph theory for detection of inauthentic algorithms

- Growing problems in social media, can even stir civil unrest
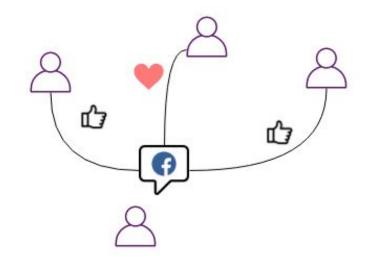
Why are inauthentic profiles dangerous?
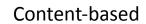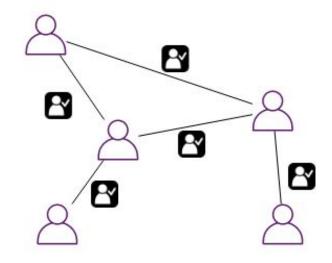
Two types of network

Content-based
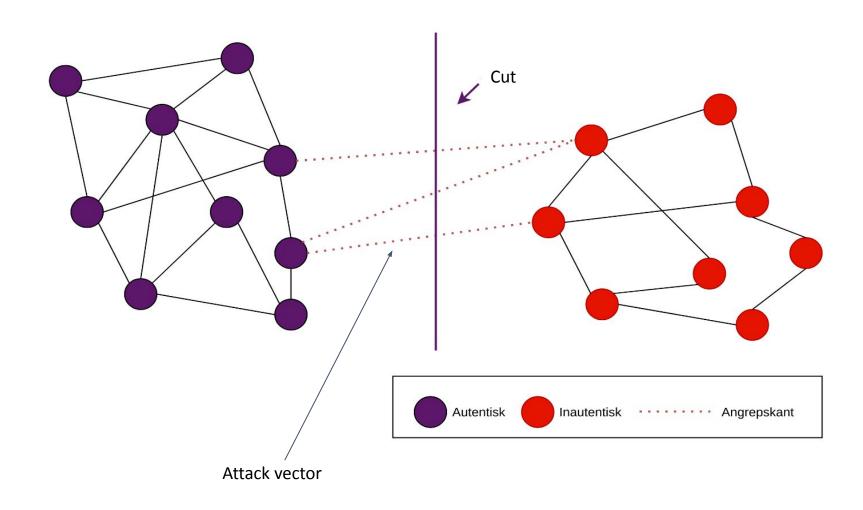
Relational

Assumption:

Cut

Attack vector

Autentisk   Inautentisk   ⋯⋯⋯ Angrepskant
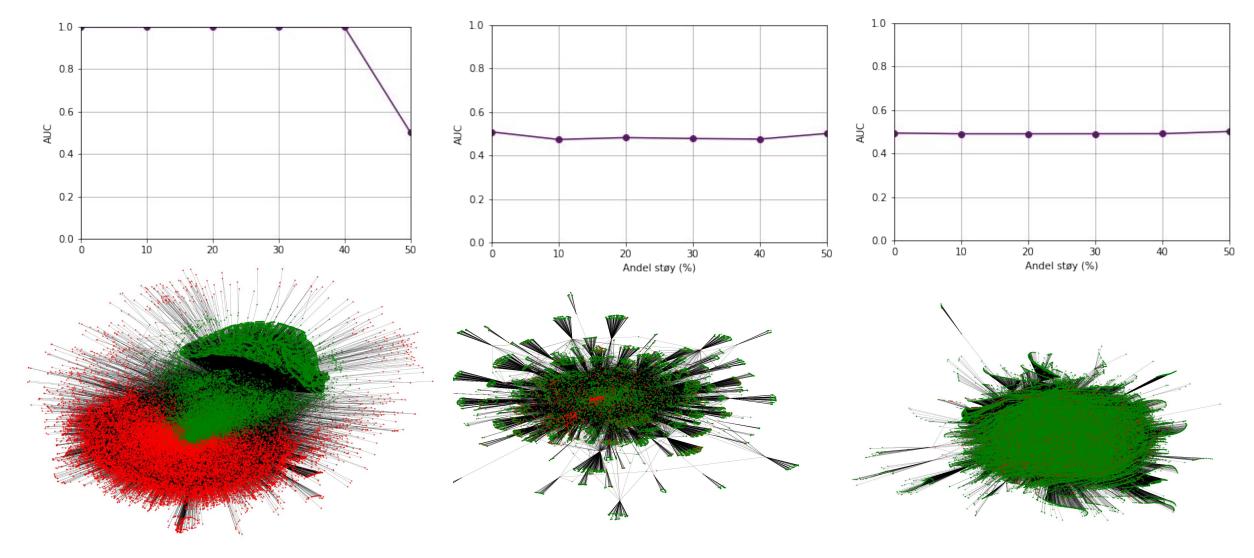
Chosen algorithms for study

- SybilSCAR
- Machine learning on relational graph
- Machine learning on content-based graph
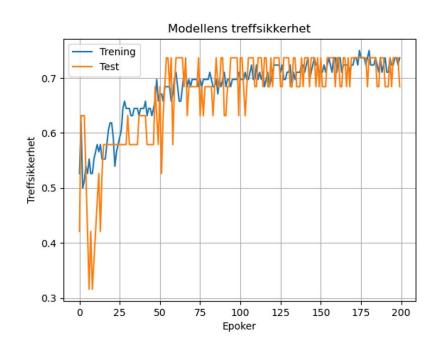
Results 1: SybilSCAR
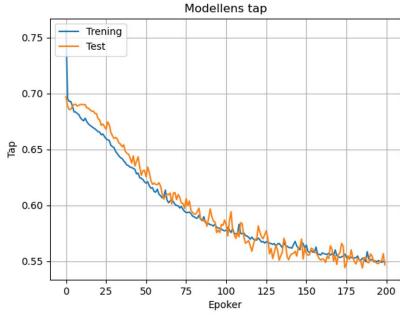
Result 2: Machine learning on relational...

Modellens treffsikkerhet

Modellens tap
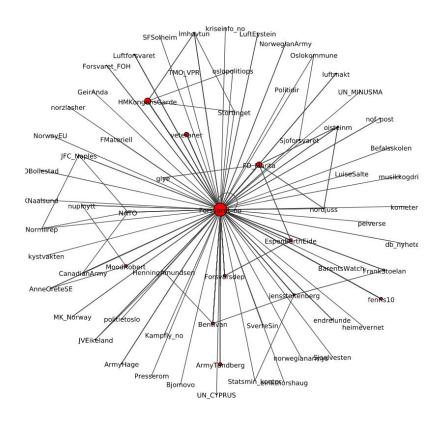
Property	F-number
Density	0,54
Global clusterin coefficient	0,65
Local clustering coefficient	0,56
Indegree centrality	0,64
Outdegree centrality	0,61
Mutuality	0,58
Assortativity	0,55
Articulation points	0,60
Totalt	**0,66**

Result 3: Machine learning on content…

F-number: 0.68

Results compared

Approach	F-number
SybilSCAR	0,50-0,99
Machine learning on relations-based graph	0,66
Machine learning on content-based graph	0,68

From the conclusion:

- **SybilSCAR** has given good results in networks where its assumptions hold, but works better in cooperation the machine learning algorithm.
- **The unsupervised learning** algorithm is assuming the biggest difference between inauthentic and authentic profiles, but this is not necessarily the case.
- **The supervised machine learning** algorithms, both of which are based on decision trees, seem to be able to find patterns, given that there are actual patterns to be found, and enough data to do so.
- **The enhanced machine learning** algorithm, neural networks, seems to be able to be more efficient at finding good patterns.

- *Nevertheless, given all the sources of error and the small difference in accuracy, it is difficult to say which of the two monitored and one amplified machine learning algorithm is best suited for the detection of inauthentic use.*

Knowledge, applicability, risks and potentials of AR / VR in the field of physiotherapy in Austria: results of an online survey

presenter and author:

Dr. Michael Suppanz, MSc

m.suppanz@fh-kaernten.at

further authors:

Sabrina Moro, MSc

Beate Salchinger, MMSc

beate.salchinger@fh-joanneum.at

Lea Harmtodt

… the presenter
Dr. Michael Alexander Suppanz, MSC. MAS
Head of the degree program Physiotherapy at FH Kärnten (Austria)

…Introduction:

✓ Augmented Reality (AR) in physiotherapy yielded positive effects, such as increasing balance, velocity, cadence, step length, stride length or efficacy to handle falls (Yoo et al., 2013). Chi et al. (2019) showed that different types of Virtual Reality (VR)- therapy could reduce neuropathic pain associated with spinal cord injuries , but the clinical significance of this analgesic effect seems unclear.

✓ There are **15,947 registered physiotherapists** in Austria (Holzweber et al., 2021).

✓ The Austrian profile of competences for physiotherapists is composed of seven roles and based on the CanMEDS 2015 Physician Competency Framework (Frank, Snell & Sherbino, 2015).

  ➢ To fulfill the **specific role of an innovator/scholar**, physiotherapists need to live and practice lifelong learning processes and they are required to develop and disseminate evidence-based knowledge (Becker, 2019; Eckler et al., 2017).

  ➢ Our research project "Connecting.Ideas4Research" in general, analyzes crowdsourcing processes in different professions.

  ➢ Our use case in physiotherapy in particular, analyzes and searches for potentials and barriers in the field of digitalization and AR among Austrian physiotherapists.

...Project Overview, Methods and Results:

Project Overview

Project Overview:
- ✓ WTZ Süd
- ✓ Connecting.Ideas4Research
- ✓ focused on open innovation science & crowdsourcing processes
- ✓ use case physiotherapy:
  - ➢ **digitalization, AR & VR**

Methods

Methods:
- ✓ **online survey: LimeSurvey,** May and June 2020
- ✓ **inclusion criteria:** all registered physiotherapists in Austria
- ✓ **distribution:** newsletter of the professional organisation, Facebook, graduates, personal emails

Results

Main categories of the survey:
- ✓ sociodemographic data
- ✓ physiotherapy and digitalization
- ✓ **physiotherapy and AR/VR**
- ✓ access to research findings
- ✓ COVID-19-crisis

3

... Sociodemographic Results:

- ✓ overall sample n=197
- ✓ excluded participants: n=80
  - ✓ unfulfilled inclusion criteria: n=5
  - ✓ unfinished questionnaires: n=75 ▲
- ➤ **analyzed sample: n=117 (w=77.8 %; m=22.2 %)**

age & experience:

n = 117	Minimum	Maximum	Mean	SD
★ Age (years)	20	60	37,56	10,66
Post-qualification experience (years)	1	40	14,52	11,10

educated at:

n = 117	n=	%
PT-School	13	11,1 %
PT-Academy	41	35,0 %
University of applied sciences	61	52,1 %
University	2	1,7 %

working conditions:

n = 117	n=	%
Employed	50	42,7 %
Self-employed	34	29,1 %
★ Both	29	24,8 %
On unpaid leave	4	3,4 %

▲ probably due to the length of the questionnaire   ★ = similarity with Holzweber et al. (2021) - annual report of the Austrian Health Register

… Results:

➢ **58.9 %** (n=69) do not know the term AR
➢ A **mean of 4.63 (± 2.09)** indicated the **relevance of AR** on a scale from 1 (not relevant) to 10 (absolute relevant)
➢ **70.9 %** (n= 83) **cannot really identify advantages of AR** in physiotherapy

Potential Benefits:
➢ increased motivation due to gaming aspects
➢ development of new therapeutic approaches

Potential disadvantages:
➢ increased costs
➢ a reduction of face to face contacts
➢ increased risk to fall

Further research is required: 83.8 % (n=98)
Identified interesting research topics :
🔍 the effect of AR on patients' **adherence or compliance** (n=6)
🔍 AR for **diagnostics** and therapy evaluation (n=6)
🔍 possible applications of AR in physiotherapy **for specific pathologies** (n=10)
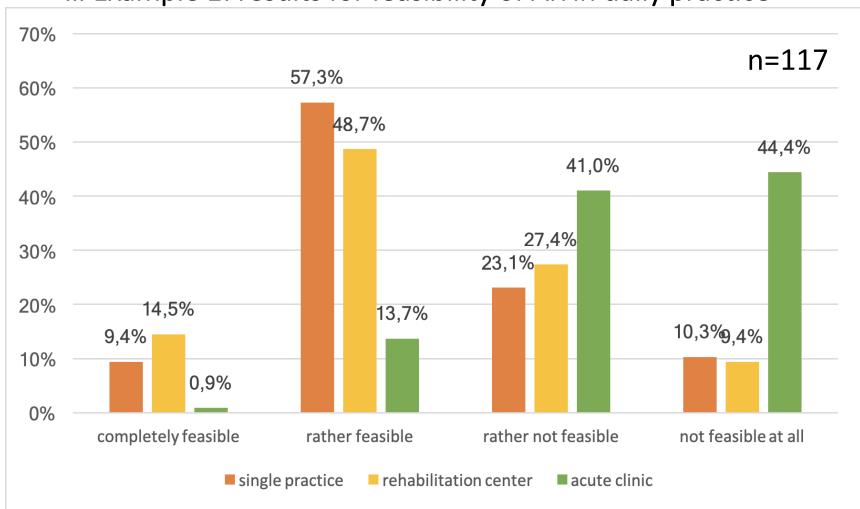
n=117

Possible explanations:
- predominant characteristics of patients
- different goals among settings
- applicability in musculoskeletal and neurological fields vs. other fields
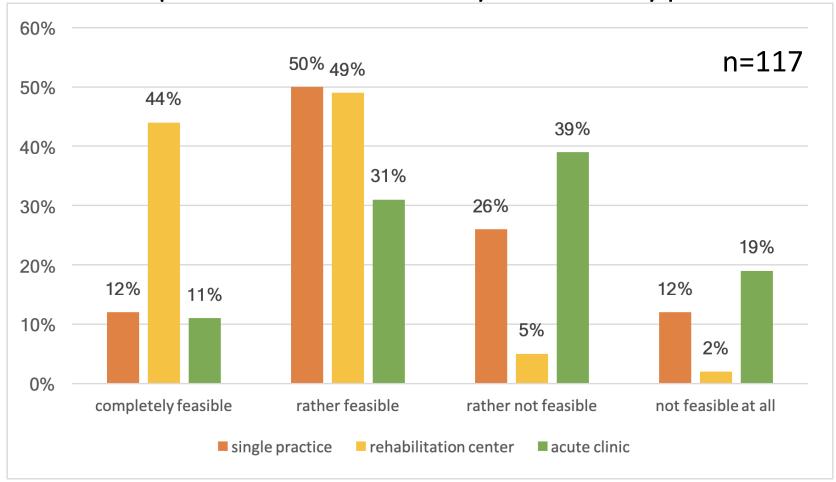
...feasibility of VR-glasses
(e.g., for supporting patients during home exercise programs with further information and real time feedback)

... Example 2: results for feasibility of AR in daily practice

...feasibility of laser projections on the ground in gait analyses
(e.g., foot prints on treadmills to influence step length and/or velocity)

... Example 3: results for feasibility of AR in daily practice

...feasibility of anti freezing canes
(e.g., laser projections on the floor helping people with Parkinsons' diseases overcoming the freezing phenomenon)

Possible explanations:
- easy handling
- AR „integrated" in an everyday object
- different patient needs

... Discussion:

> **Representativeness of the sample size:** comparison with the population of Austrian physiotherapists (Holzweber et al., 2021):

   - ✓ **age:** mean age is comparable
   - ✓ **education status:** not representative
   - ✓ **working conditions:** not representative (except for the group of physiotherapists who are employed and self-employed)

> **Limitations:** small sample size, diversity of sociodemographic characteristics, reliability questionable, difficulties contacting participants

> **Possible solutions:** create legal regulations so that the professional register can be used for distribution

... Conclusion & Perspectives:

Regarding on our results Austrian physiotherapists who filled out the survey

➢ have a **lack of knowledge** regarding AR/VR

➢ see **advantages and disadvantages** using this technology

Although the sample size is not representative, similar concerns about AR were concluded as did Banasiadi et al. (2020):

✓ **special knowledge and education is needed before using these tools**

✓ the **therapeutic setting** and **patients' pathologies** could influence physiotherapists' decision if they used AR-systems in their daily practice

✓ **further research** is required to analyze the effects of AR/VR in healthcare and especially in the field of physiotherapy

... References:

- Baniasadi, T., Ayyoubzadeh, S. M., Mohammadzadeh, N. (2020). Challenges and Practical Considerations in Applying Virtual Reality in Medical Education and Treatment. Oman Med J, 35(3), e125. doi: 10.5001/omj.2020.43

- Chi, B., Chau, B., Yeo, E., Ta, P. (2019). Virtual reality for spinal cord injury-associated neuropathic pain: Systematic review. Annuals of Physical and Rehabilitation Medicine, 62(1), p. 49-57. https://doi.org/10.1016/j.rehab.2018.09.006

- Frank, J. R., Snell, L. & Sherbino, J. (2015) . CanMEDS 2015 Physician Competency Framework. Ottawa: Royal College of Physicians and Surgeons of Canada. Accessed on 28th of July 2021, under https://www.researchgate.net/publication/289254803_CanMEDS_2015_Physician_Competency_Framework

- Holzweber, L., Zach, M., Gruböck, A., Juraszovich, B., Mathis-Edenhofer, S., Rappold, E., Wallner, A. (2021). Annual report health professions register 2020. accessed on 25th of August 2021, under https://www.sozialministerium.at/dam/jcr:f8e3ebc2-46fe-4b31-abb6-0b0860a8edde/GBR-Jahresbericht_2020.pdf

- Yoo, H.-N., Chung, E., Lee, B.-H. (2013). The Effects of Augmented Reality-based Otago Exercise on Balance, Gait and Falls Efficacy of Elderly Women. Journal of Physical Therapy Science, 25(7), p. 797-801. https://doi.org/10.1589/jpts.25.797

IARIA

– Ethics and (Explainable) AI –
Semantic AI & the Role of the Knowledge Scientist

Efstratios (Stratos) Kontopoulos, Knowledge Scientist, Catalink Ltd, Cyprus
e.kontopoulos@catalink.eu

catalink

About Me…

- PhD in Semantic Web Technologies

- >15 years of experience on Semantic Web theory and practice both in academia and in industry
    - '05-'10: Research Assistant, Dept. of Informatics, Aristotle Univ. of Thessaloniki, Greece
    - '11-'13: Academic Associate, International Hellenic University, Greece
    - '14-'16: CTO, SentiGeek
    - '13-'19: Senior Researcher, Centre for Research & Technology Hellas (CERTH), Greece
    - '19-'20: Semantic Technologies Engineer, Elsevier, UK
    - '20-now: Knowledge Scientist, Catalink Ltd, Cyprus

- Areas of expertise
    - Knowledge-based Applications & Semantic Reasoning
    - Computer Vision
    - Machine Learning

- Strong presence in EU-funded research projects

- Wide network of contacts with Universities, Research Institutes, Industry, Municipalities & Public Orgs

The Rise of eXplainable AI (XAI)

- Current widespread AI solutions work like "black boxes" lacking the ability to explain their decisions and actions to human users

- Lack of trust & skepticism against current AI solutions

- EU guidelines on ethics in AI explicitly indicate the requirement for XAI

- Upcoming 3rd wave of AI will lead to **Whitebox AI**: explainability, argumentation & abstraction

- Most affected domains: Medicine, Legal, Finance, Transportation / Autonomous Vehicles, Security, Military

*

User

- Why did you do that?
- Why not something else?
- When do you succeed?
- When do you fail?
- When can I trust you?
- How do I correct an error?
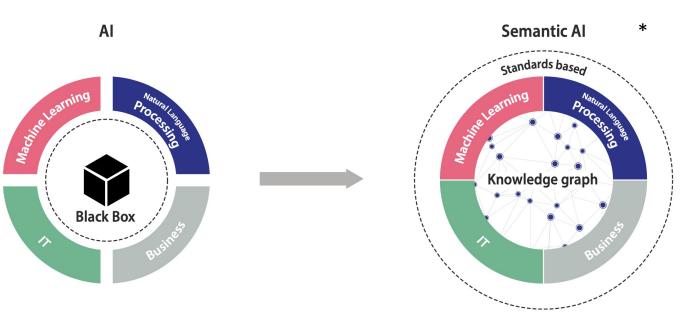
Semantic AI & Knowledge Graphs (KGs)

- Semantic AI
  - More than "*yet another ML algorithm*"
  - Rather, it is an **AI strategy**
  - Fuses symbolic & statistical AI
  - Does not replace but instead boosts existing IT systems

- Semantic KGs
  - A semantic KG is at the heart of a semantic AI architecture
  - Models of knowledge domains, represented as large networks of semantic entities & relationships
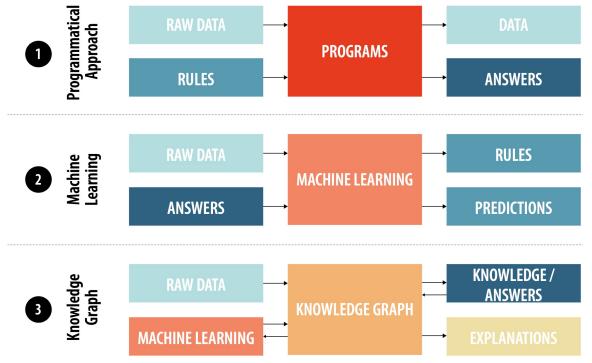
The Role of Semantic KGs in XAI

- <u>As Gartner states</u> *"Semantic AI has the advantage of being explainable by design."*

- KGs are natively developed to be explainable

- XAI requires domain information to explain a system's decisions => KGs

- Need of human-in-the-loop (HITL) to verify new assertions

Multiple Skills Required

The introduction of semantic AI as a new architecture paradigm introduces the need for **new combinations of skills**

Myself as an Example…

My duties now (Catalink) and in the recent past (Elsevier, CERTH):

- Leading a small, agile team of software developers & junior researchers
- Analysing the domain of discourse in each project
- Designing & developing semantic models/ontologies/KGs, in close collaboration with end-users
- Developing data processing pipelines to manipulate/transform/merge data
- Deploying the required semantic infrastructure (triplestores, queries, semantic reasoning, APIs) & its communication with the rest of the platform
- Preparation of project deliverables, reports & documentation
- Representing the org in relevant meetings & activities

So, what does the above list make me?

The Emergence of the Knowledge Scientist

Knowledge scientists* should [combine multiple hard & soft skills](#)

- Hard skills
  - Data modelling, knowledge representation, ontology engineering
  - Data access & transformation: query & programming languages
  - Knowledgeable of analytical & ML methods

- Soft skills
  - Collaborate with domain experts, business users, data scientists, data engineers
  - Excellent communication skills
  - both a "people person" and a "geek"

Thank You!

NexTech Experts Panel II

Impending Technical Societal Challenges: Qvo Vadis?

(digitization, digital awareness, safety and threats, personal data, discovering relevant data, online content, fake news, social media, citizen behavior, health accessibility, psychological/physical addiction, etc.)
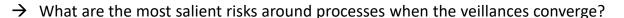
NexTech 2021

Society is a facing a convergence of the veillances. What frameworks might we consider to mitigate the risks?

The Convergence of the Veillances: *Benefits & Risks*

Christine Perakslis, Arizona State University, USA cperaksl@asu.edu

- Converging Veillances
  - Surveillance
  - Sousveillance
  - Dataveillance
  - Uberveillance

- Privacy Border Crossings

- ISO 31000: Mining the Risks

→ What are the most salient risks around processes when the veillances converge?
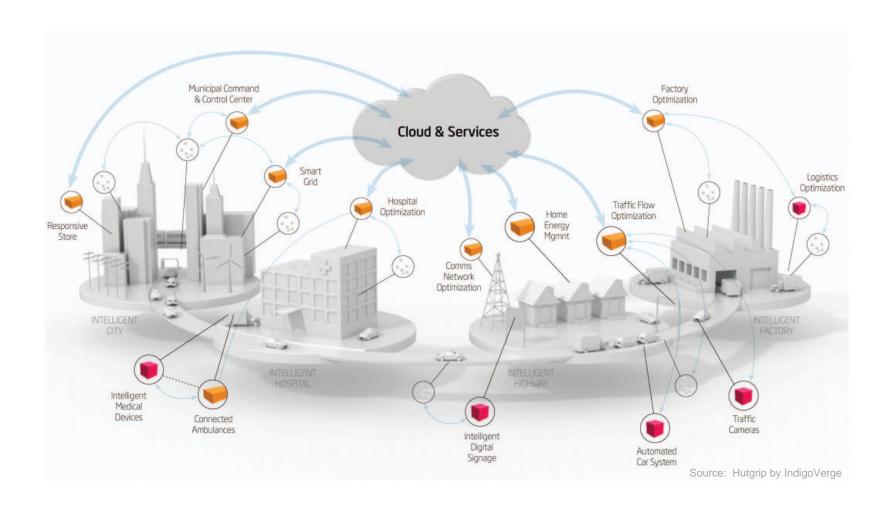
→ What are Privacy Border Crossings to consider?

→What are frameworks to consider to mitigate the risks?

Source: Hutgrip by IndigoVerge

Asynchronous (static) ←——————————→ Synchronous (real-time)

One-to-one ←——————————→ Many-to-many

Disaggregated ←——————————→ Aggregated

Overt manner ←——————————→ Covert manner

ISO International Organization of Standards
Process Overview

COMMUNICATION & CONSULTATION

ESTABLISHING THE CONTEXT
RISK IDENTIFICATION
RISK ANALYSIS
RISK EVALUATION
RISK TREATMENT

RISK ASSESSMENT

MONITOR & REVIEW

THE VEILLANCES
(Emerging future state = Convergence)

Surveillance
Dataveillance
Sousveillance
Uberveillance
IPlant QSelf
Sensor View
Person View
Street View
Satellite View
Reconnaissance Satellites
Information Highways
Lifelogging

Equiveillance is a fair, just, and equal sensing, i.e. when surveillance and sousveillance are both present.

Priveillance™ is a broad-encompassing series of inventions, protocols, and best-practices; it is at the intersection of surveillance, sousveillance, and privacy.

Panoptic veillance: the few watching the many, leading to self-watching

Synoptic veillance: the many watching the few

Liquid surveillance: watching that is dynamic, moving restlessly from site to site and using various types of technologies

Banoptic surveillance: exclusion of individuals or social groups via surveillance techniques

Participatory veillance: voluntary participation as a subject of veillance

Social veillance: watching each other via social media

Dataveillance/panspectric veillance: watching that involves the use of digital data technologies rather than human senses alone

Algorithmic veillance: watching using computer algorithms and digital data

---

MODEL for CONSEQUENCES:
"Security Layers" aka "Concentric Circles of Protection" or "Security in Depth"

Patrolled Community
Gated Community
Secured House Gate
Secured Exterior Doors & Windows
Secured Interior Room Door
Locked Cabinet
(Human)

5 D's: Detect, Deter, Deny, Delay, Defend

PRIVACY BORDER VIOLATIONS (Marx)

- **Natural Borders** – Physical (i.e. freedom from invasion in such material realms as walls, doors, clothing, facial expressions, and verbal conversations.)
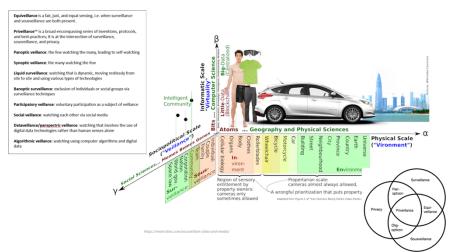
- **Social Borders** – Social System (i.e. the right to confidentiality/freedom from invasion of privacy by others in the social system)

- **Spatial or Temporal Borders** – Delineation (i.e. the right to establish delineation in work, personal, religious, etc. spheres; rights to maintain decoupled spheres.)

- **Ephemeral or Transitory Borders** - Eradicable (i.e. the right to have information forgotten, or to delete permanently a past extemporaneous or regrettable action)

ADDITIONAL BORDER CONSIDERATION (2016):

- **Physio-psychological Borders** (i.e. boundaries of the internal realm of the individual's human system such as physiological and psychological; the expectations of personal autonomy and self-determination of his or her human system, including ownership of the information.

Risk Identification

Risk Category	Risk Event (Processes)	Cause	MODEL of Consequences: Privacy Borders (Marx)	MODEL of Consequence Security Layers (USDoA)
Identify the relevant risk category	Capture the potential event	Describe the potential causes of event occurring	Describe the main impact of risk event on society relative to: *PRIVACY BORDERS (Marx, 2001)*	Describe the main impact of risk event on society *SECURING BORDERS* Principles
Emerging Technologies (in Societal Context or in Sociocultural context)	PROCESSES • Insightf... • Imperce... • Incomp... • Indelibl... • Invasive... • Involun...	PREVIOUS RESEARCH (RISK): • **Compulsory Environs** (e.g. Opt-in to Participate in Society/economical car insurance) • **Vulnerability** (e.g Murky & Mutable Terms & Conditions) • **Diminished Regulation of Privacy** (e.g. Being opted-in by "association/proximity")		

Surveillance

Dataveillance

Sousveillance

Uberveillance

iPlant   QSelf

Sensor View

Person View

Street View

Satellite View

GoogleMaps

Google Cars

Google Glass

Lifelogging

Buildings, Roadways

Geographical Infosys

Michael, Michael & Abbas, 2009;
adapted with Perakslis 2013

Surveillance

Dataveillance

Sousveillance

Uberveillance

GoogleMaps

Google Cars

Google Glass

iPlant

Sensor View

QSelf

Lifelogging

Buildings, Roadways

Geographical Infosys

Person View

Street View

Satellite View

Michael, Michael & Abbas, 2009;
adapted with Perakslis 2013

Michael, Michael & Abbas, 2009; adapted with Perakslis 2013

VTrans Mapillary Quick Reference Guide (Hyperlinks are Blue**)** Press CTRL + click to open links

http://files.vtrans.vermont.gov/amp/Mapillary/VTrans_Mapillary_Quick_Guide.pdf

Ground-based imagery / Videologging

Figure 2: Excerpt of a digital DNA e...
associated to a given character, a...

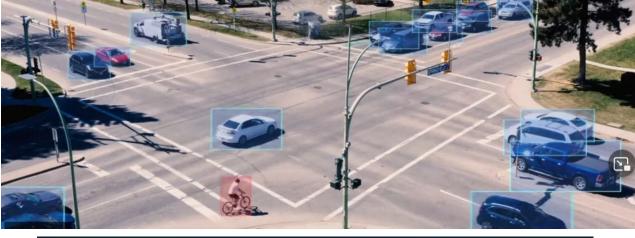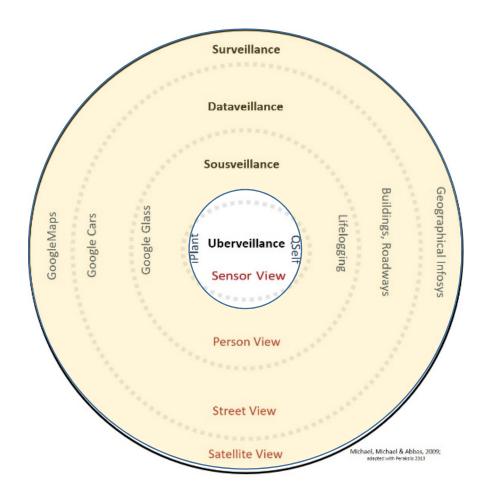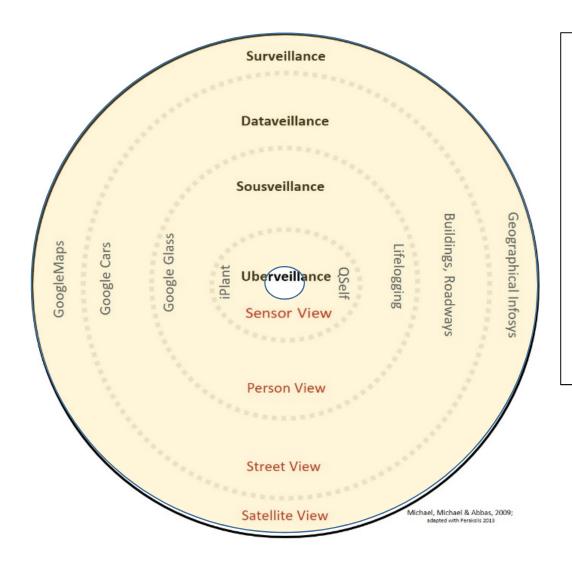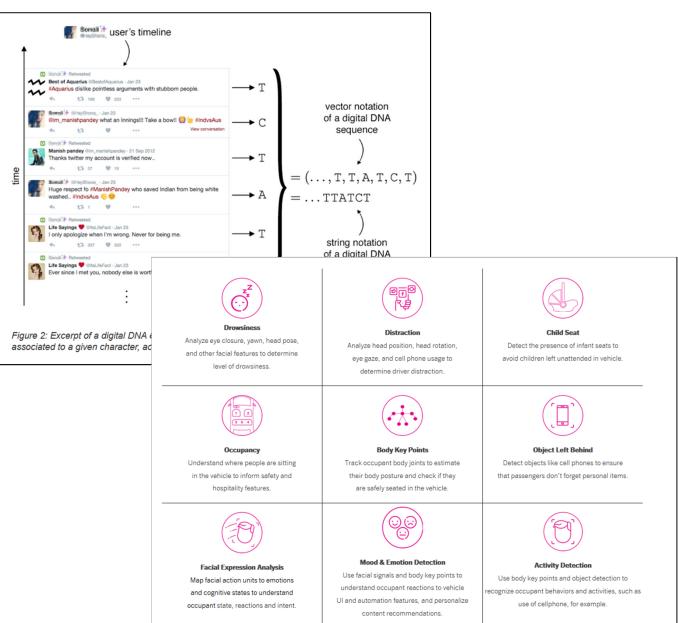| Drowsiness	Distraction	Child Seat
Analyze eye closure, yawn, head pose, and other facial features to determine level of drowsiness.	Analyze head position, head rotation, eye gaze, and cell phone usage to determine driver distraction.	Detect the presence of infant seats to avoid children left unattended in vehicle.
Occupancy	**Body Key Points**	**Object Left Behind**
Understand where people are sitting in the vehicle to inform safety and hospitality features.	Track occupant body joints to estimate their body posture and check if they are safely seated in the vehicle.	Detect objects like cell phones to ensure that passengers don't forget personal items.
Facial Expression Analysis	**Mood & Emotion Detection**	**Activity Detection**
Map facial action units to emotions and cognitive states to understand occupant state, reactions and intent.	Use facial signals and body key points to understand occupant reactions to vehicle UI and automation features, and personalize content recommendations.	Use body key points and object detection to recognize occupant behaviors and activities, such as use of cellphone, for example.

1. Insightfulness

With context-awareness and context-adaption, networks of ubiquitous devices will be continuously "on" and autonomously learning behaviors. With data gleaned across all veillances, devices will assess humans in multiple contexts, capacities, and over time. This is likely to lead to a capability for the system to have rich insightfulness, or a precise and profound understanding of humans in the current, but also future, state. As the veillances converge, will this yield a world in which the watchers have an unique advantage with profound insight derived through an accurate, multilayered, intuitive understanding of the human?

2. Imperceptible

As networks are operating behind the line of visibility, humans are not likely to comprehend the scope, reach, or even timing of data practices. The processes and procedures are likely to be imperceptible. Users could be blinded to what is collected, by whom, for how long, how it is synthesized with other data, and who owns the data now - or in the future. As the veillances converge, will this yield a world in which the man does not perceive the watching, and as a result, nor the consequences of being watched?

3. Incomprehensibility

Our current state of terms and conditions are often murky and/or mutable. Additionally, the average human is not likely to comprehend the wide-ranging system, nor the risks associated across multiple organizations sharing data. The system is likely to be incomprehensible for the consumer. Simpler technologies have already proven to be complex and convoluted to the average consumer. As the veillances converge, will this yield a world in which a human must opt-in to stipulations that are unrealistic to comprehend?

4. Indelibility

Data may become ineradicable. Our digital footprints are likely to leave an indelible history of analyzable behaviors, especially if we do not own our data, or if data were shared and stored elsewhere in the veillances. As the veillances converge, will this yield a world in which the human's behaviors cannot be forgotten? Will humans comprehend the long-term effects of being watched?

5. Invasiveness

As we allow technology to listen inside of us and to listen in to our relationships, we are likely to create systems in which not only our behaviors are predicted, but perhaps even our intent. As the veillances converge, will this yield a world in which such intrusion into the inner sanctum of a human could place dignity at risk – even if unintended?

6. Involuntariness

It is evermore compulsory for an individual to subscribe to cloud-based email to be gainfully employed or to receive extensive services across disciplines at a hospital. More often, individuals are pressured to opt-in to belong and benefit socially, or to benefit financially (e.g. discounts offered by an insurance company). As the veillances converge, will this yield a world in which man must opt-in to technology to participate in society?

- **Natural Borders** – Physical (i.e. freedom from invasion in such material realms as walls, doors, clothing, facial expressions, and verbal conversations.)

- **Social Borders** – Social System (i.e. the right to confidentiality/freedom from invasion of privacy by others in the social system)

- **Spatial or Temporal Borders** – Delineation (i.e. the right to establish delineation in work, personal, religious, etc. spheres; rights to maintain decoupled spheres.)

- **Ephemeral or Transitory Borders** - Eradicable (i.e. the right to have information forgotten, or to delete permanently a past extemporaneous or regrettable action)

ADDITIONAL BORDER CONSIDERATION (2016):

- **Physio-psychological Borders** (i.e. boundaries of the internal realm of the individual's human system such as physiological and psychological; the expectations of personal autonomy and self-determination of his or her human system, including ownership of the information.

Appendix A: *The 7 Foundational Principles*

1. *Proactive* not Reactive; *Preventative* not Remedial

The *Privacy by Design* (PbD) approach is characterized by proactive rather than reactive measures. It anticipates and prevents privacy invasive events *before* they happen. PbD does not wait for privacy risks to materialize, nor does it offer remedies for resolving privacy infractions once they have occurred — it aims to *prevent* them from occurring. In short, *Privacy by Design* comes before-the-fact, not after.

2. Privacy as the *Default Setting*

We can all be certain of one thing — the default rules! *Privacy by Design* seeks to deliver the maximum degree of privacy by ensuring that personal data are automatically protected in any given IT system or business practice. If an individual does nothing, their privacy still remains intact. No action is required on the part of the individual to protect their privacy — it is built into the system, *by default*.

3. Privacy *Embedded* into Design

Privacy by Design is embedded into the design and architecture of IT systems and business practices. It is not bolted on as an add-on, after the fact. The result is that privacy becomes an essential component of the core functionality being delivered. Privacy is integral to the system, without diminishing functionality.

4. Full Functionality — *Positive-Sum,* not Zero-Sum

Privacy by Design seeks to accommodate all legitimate interests and objectives in a positive-sum "win-win" manner, not through a dated, zero-sum approach, where unnecessary trade-offs are made. *Privacy by Design* avoids the pretense of false dichotomies, such as privacy *vs.* security, demonstrating that it *is* possible to have both.

5. End-to-End Security — *Full Lifecycle Protection*

Privacy by Design, having been embedded into the system prior to the first element of information being collected, extends securely throughout the entire lifecycle of the data involved — strong security measures are essential to privacy, from start to finish. This ensures that all data are securely retained, and then securely destroyed at the end of the process, in a timely fashion. Thus, *Privacy by Design* ensures cradle to grave, secure lifecycle management of information, end-to-end.

6. *Visibility* and *Transparency* — Keep it *Open*

Privacy by Design seeks to assure all stakeholders that whatever the business practice or technology involved, it is in fact, operating according to the stated promises and objectives, subject to independent verification. Its component parts and operations remain visible and transparent, to users and providers alike. Remember, trust but verify.

7. *Respect* for User Privacy — Keep it *User-Centric*

Above all, *Privacy by Design* requires architects and operators to keep the interests of the individual uppermost by offering such measures as strong privacy defaults, appropriate notice, and empowering user-friendly options. Keep it user-centric.

- Anticipatory Ethics
- Privacy by Design (PbD)
- The International Associations of Impact Assessments' (IAIA)
- Social Impact Assessment (SIA)
- Privacy Impact Assessment (PIA)

Thank you for your time.