Institute of Biophysics and Biomedical Engineering

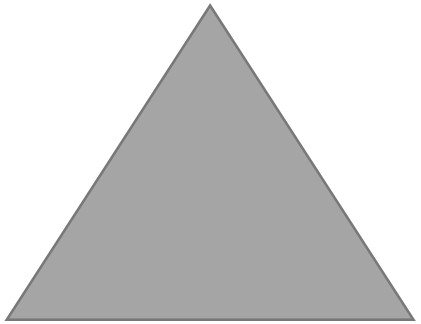
IBEB

MEDPERSYST – “Synaptic networks and Personalized Medicine Approaches to Understand Neurobehavioural Diseases Across the Lifespan”




Innovation

MSc and PhD programs
ERASMUS
Outreach



Education

Business

PETsys Electronics
NeuroPsyAI
NEUROELECTRICS

Brain Connectivity
and Dynamics

Brain Stimulation and
Neuro-Rehabilitation

Cancer Therapy
and Drug Delivery

Medical Imaging
and Diagnosis

Over a third of the European population suffers from brain diseases.

This are chronic, lifelong conditions that heavily impact individuals and their families.

Estimated yearly costs of about 800 billion euros - 35% of Europe's total disease burden

Someone in the world develops dementia every 3 seconds. There were an estimated 46.8 million people worldwide living with dementia in 2015.

This numbers are expected to climb over the coming decades.

The rising prevalence and mounting economic burden of brain disorders pose a large and growing threat to every government in the world.

Synaptic networks and Personalized Medicine Approaches to Understand Neurobehavioural Diseases Across the Lifespan

Synaptic networks are a key target in the vast majority of neurobehavioural disorders across the lifespan.

Evidence from multiple disciplines supports a pivotal role for the synaptic neurotransmitters both in the disease mechanisms or as targets for pharmacological therapy.

The pathophysiological involvement of various neurotransmitter systems is increasingly recognized, with a central role for dopamine, glutamate, GABA and serotonin.

Focusing at the same processes across diseases, modalities, and academic disciplines…

Target the same synaptic networks, affected in distinct manners, across a consortium, to provide new perspectives and cross-fertilizing approaches

ICVS/3B's
Associate Laboratory
University of Minho

University of Aveiro
ibimed
institute for biomedicine

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GCATA101010
ATTG10101010
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BioISI
Biosystems and Integrative Sciences Institute

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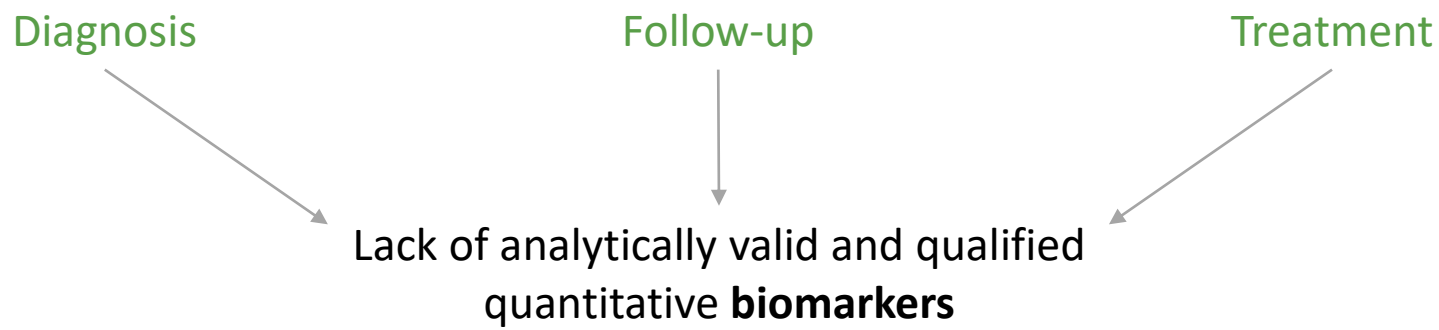
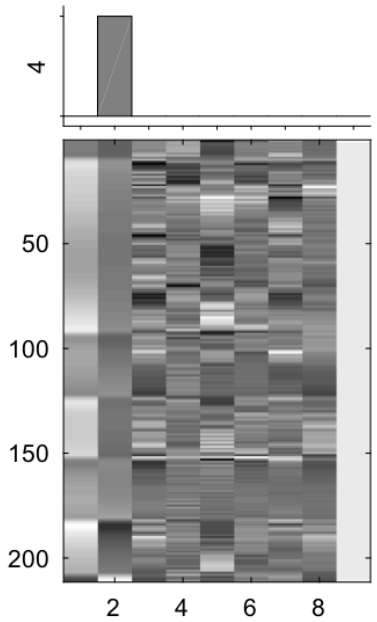


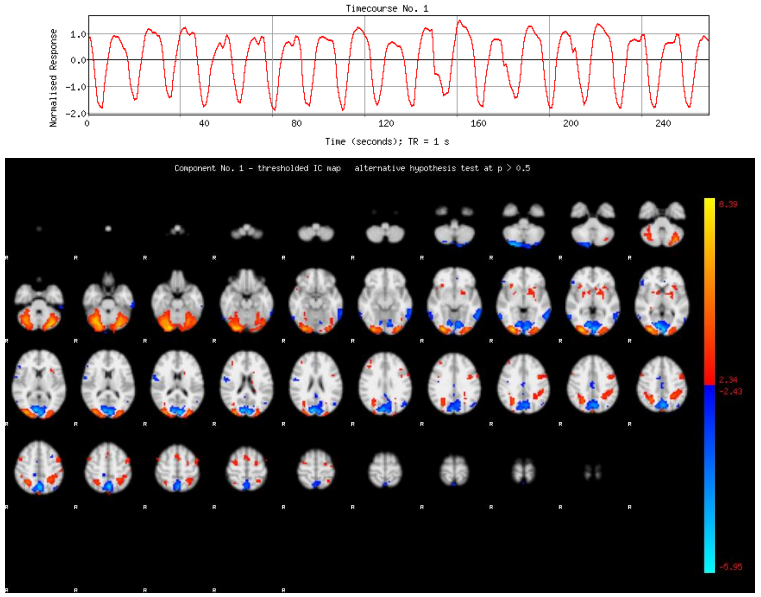
We need to move away from a purely subjective (symptom-based) methodology towards objective quantitative biomarkers

Integration

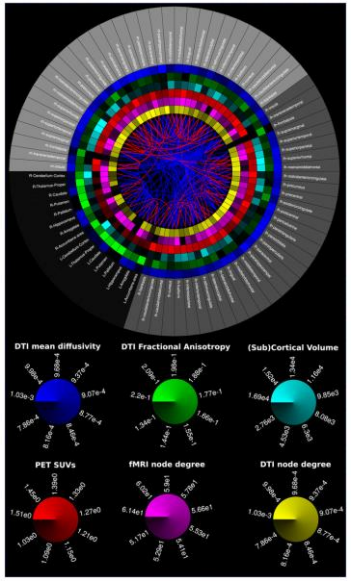
An integrated approach across diseases affecting similar biological processes will be cross-fertilizing - Integrate multimodal approaches; Integrate multidisciplinary know-how



General Linear Model



Independent Component Analysis



Functional Connectivity

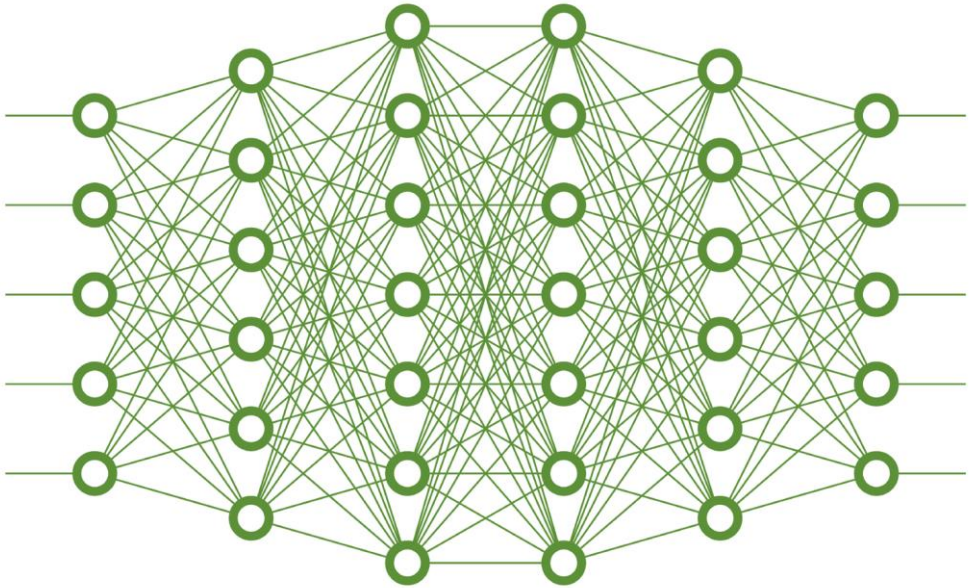
Deep Learning

Vieira, Sandra, Walter HL Pinaya, and Andrea Mechelli. "Using deep learning to investigate the neuroimaging correlates of psychiatric and neurological disorders: Methods and applications." Neuroscience & Biobehavioral Reviews 74 (2017): 58-75.

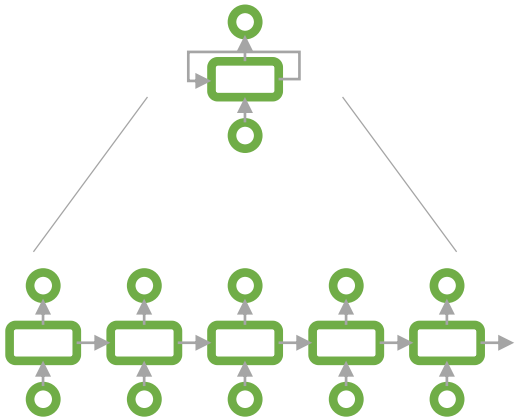
Plis, Sergey M., Devon R. Hjelm, Ruslan Salakhutdinov, Elena A. Allen, Henry J. Bockholt, Jeffrey D. Long, Hans J. Johnson, Jane S. Paulsen, Jessica A. Turner, and Vince D. Calhoun. "Deep learning for neuroimaging: a validation study." Frontiers in neuroscience 8 (2014): 229.

Munsell, Brent C., Chong-Yaw Wee, Simon S. Keller, Bernd Weber, Christian Elger, Laura Angelica Tomaz da Silva, Travis Nesland, Martin Styner, Dinggang Shen, and Leonardo Bonilha. "Evaluation of machine learning algorithms for treatment outcome prediction in patients with epilepsy based on structural connectome data." Neuroimage 118 (2015): 219-230.

Kim, Junghoe, Vince D. Calhoun, Eunsoo Shim, and Jong-Hwan Lee. "Deep neural network with weight sparsity control and pre-training extracts hierarchical features and enhances classification performance: Evidence from whole-brain resting-state functional connectivity patterns of schizophrenia." Neuroimage 124 (2016): 127-146.



LSTM

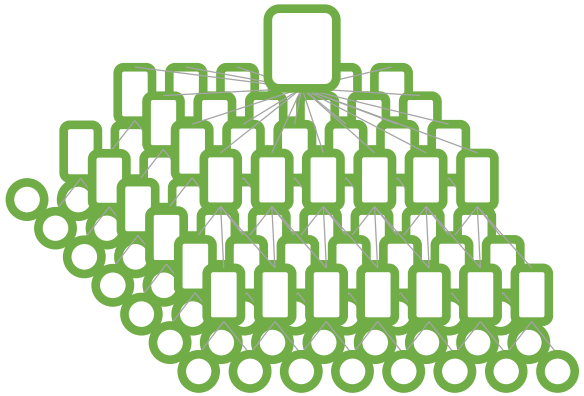


LSTMs allow information to persist between units;

Application to sequences or time-series:

- Speech recognition
- Language models

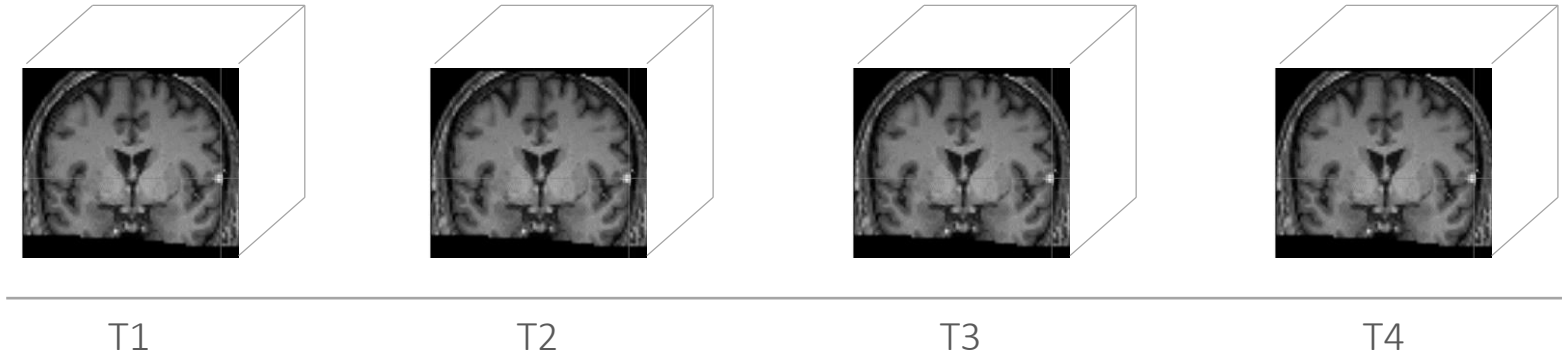
CNN



CNNs have the explicit assumption that the inputs are images;

Application in image analysis:

- Face recognition
- Image classification



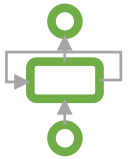
4D

X

Y

Z

T

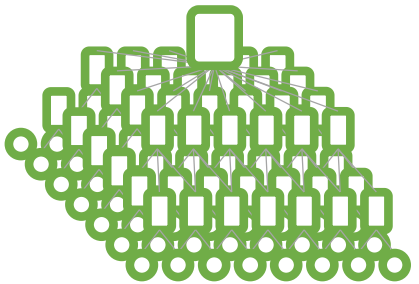


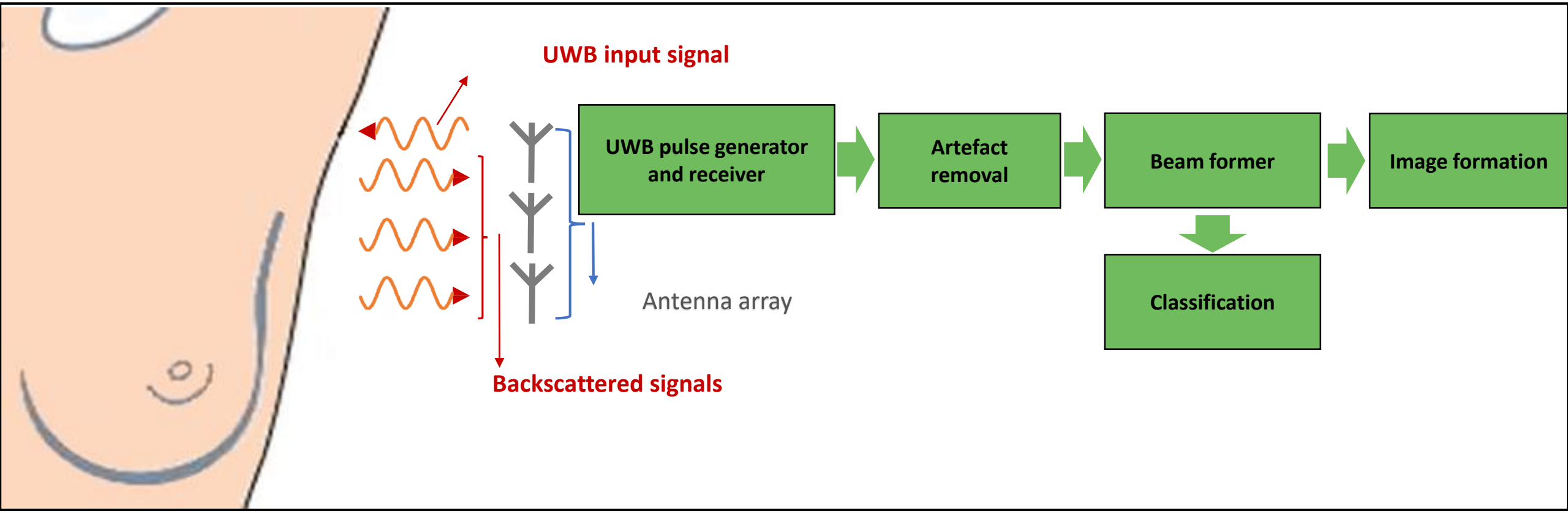
3D

X

Y

Z



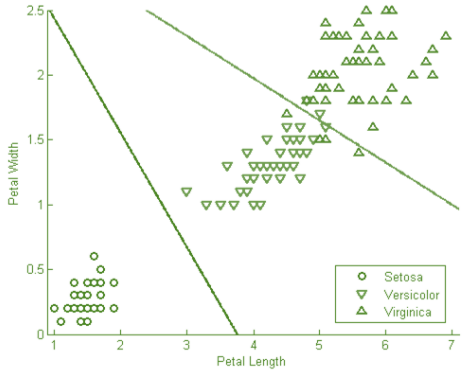

UWB input signal
UWB pulse generator and receiver
Artefact removal
Beam former
Image formation
Classification
Antenna array
Backscattered signals


Malign / Benign

→ Classification methods:

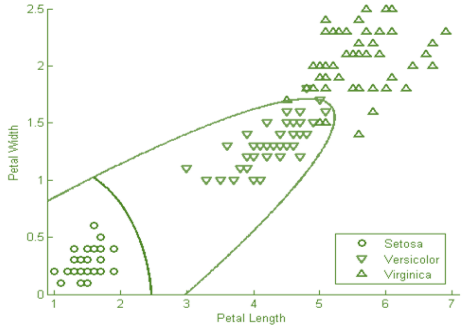
Linear Discriminant Analysis (LDA)

Groups with multivariate normal Gaussian distributions and same covariance matrix



Quadratic Discriminant Analysis (QDA)

Groups with multivariate normal Gaussian distributions but different covariance matrices



Support Vector Machines (SVM)

Linearly inseparable data transformed to higher-dimensional space, using a Kernel