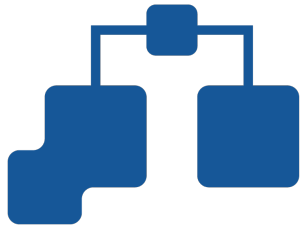
Introduction BIASlab

“Bayesian Intelligent Autonomous Systems”

Bert de Vries

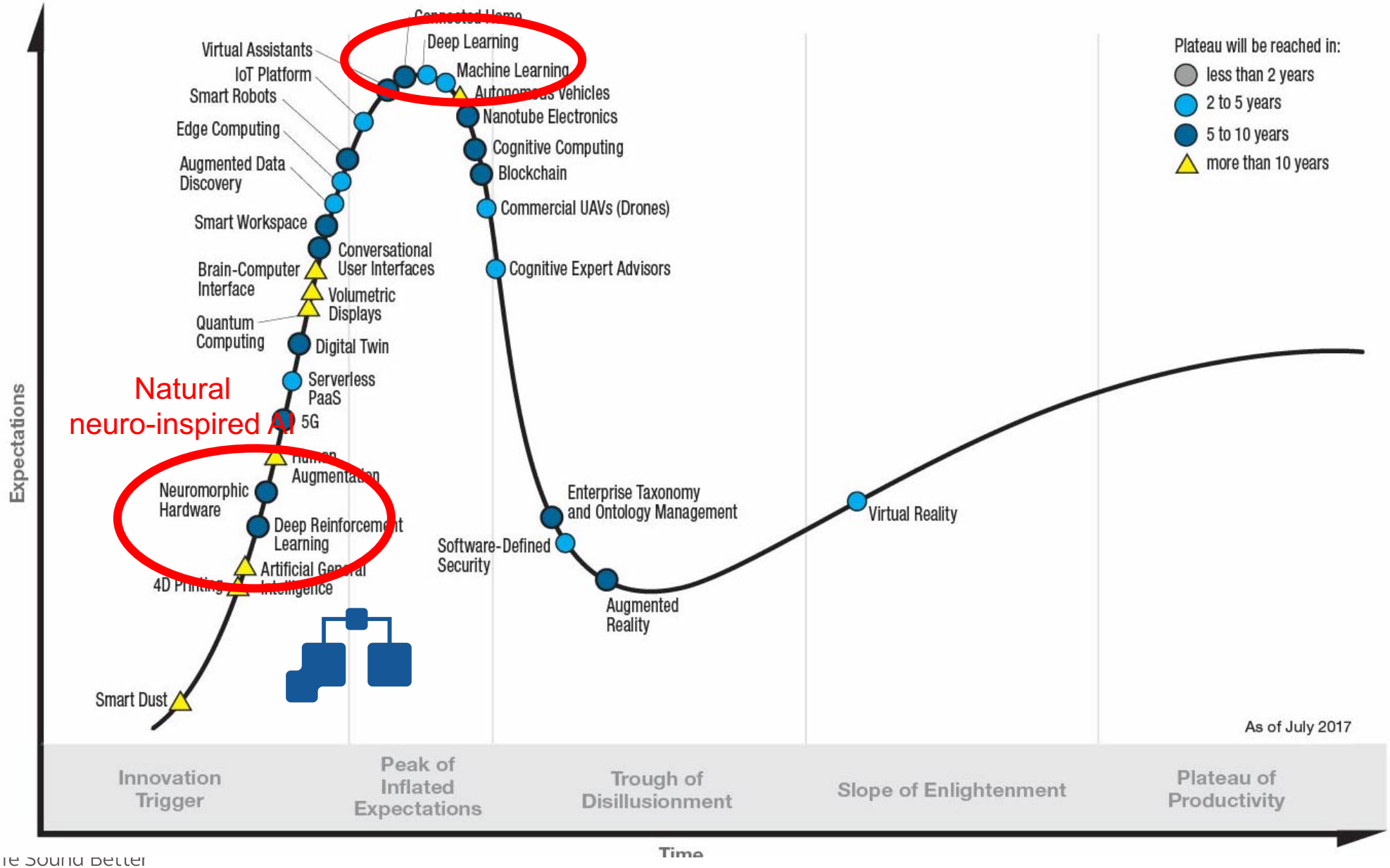
TU Eindhoven

2019

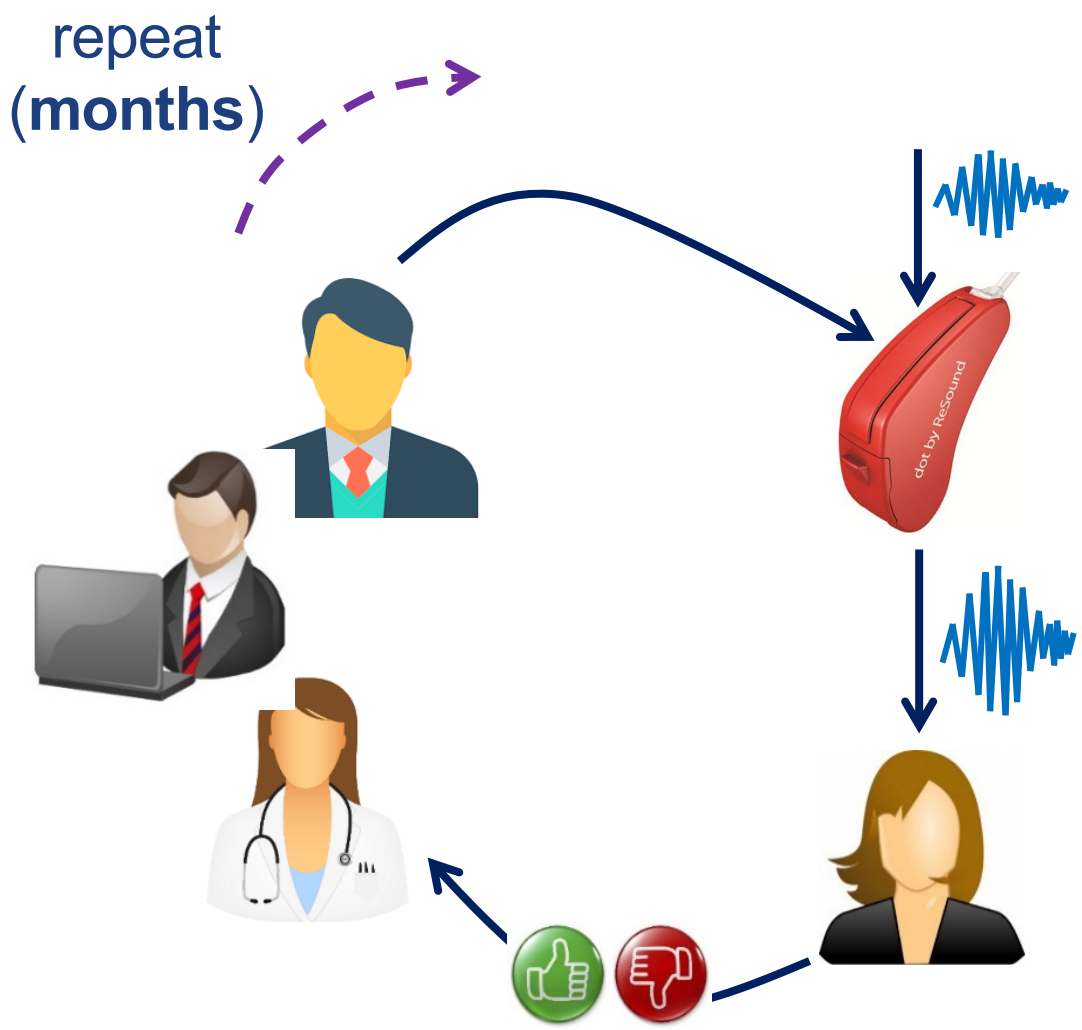


http://biaslab.org

Gartner Hype Cycle for Emerging Technologies, 2017



From Offline to Situated HA Design



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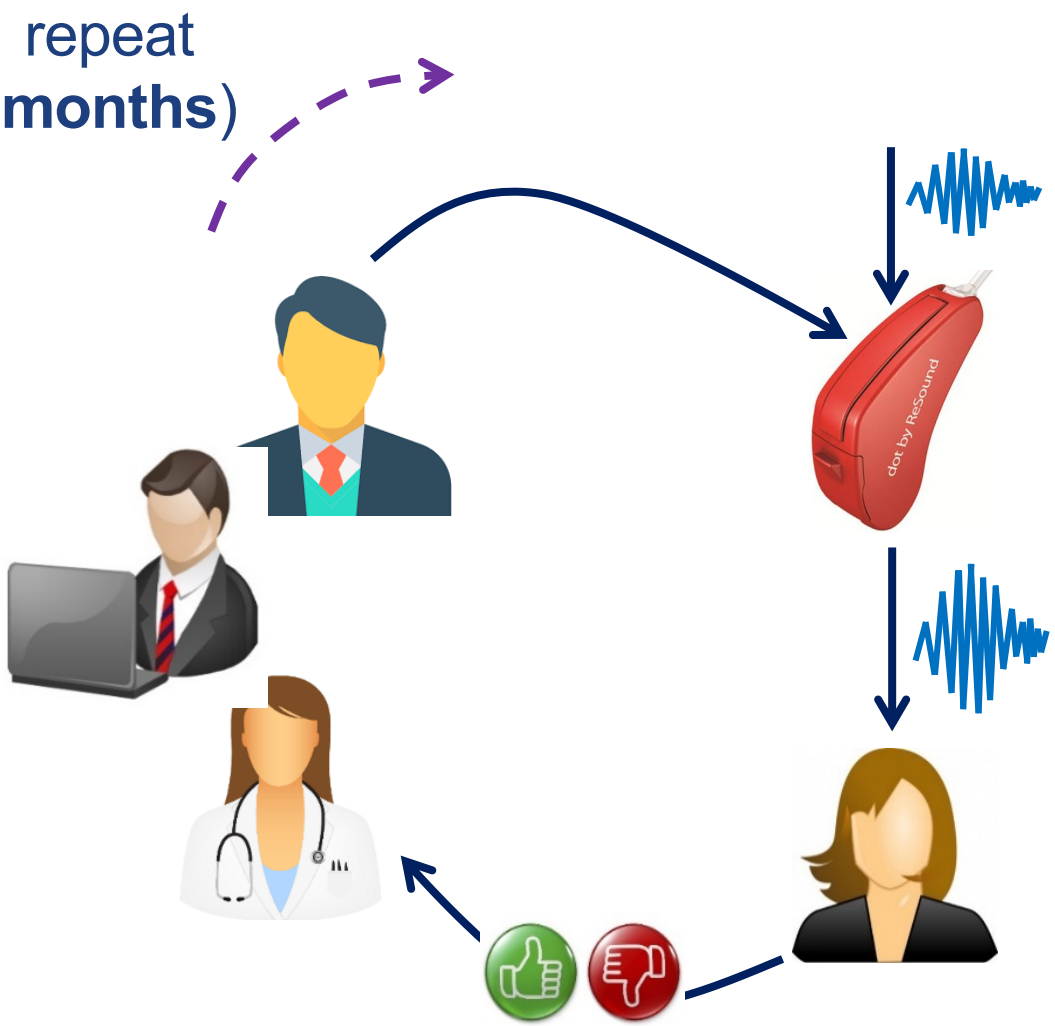
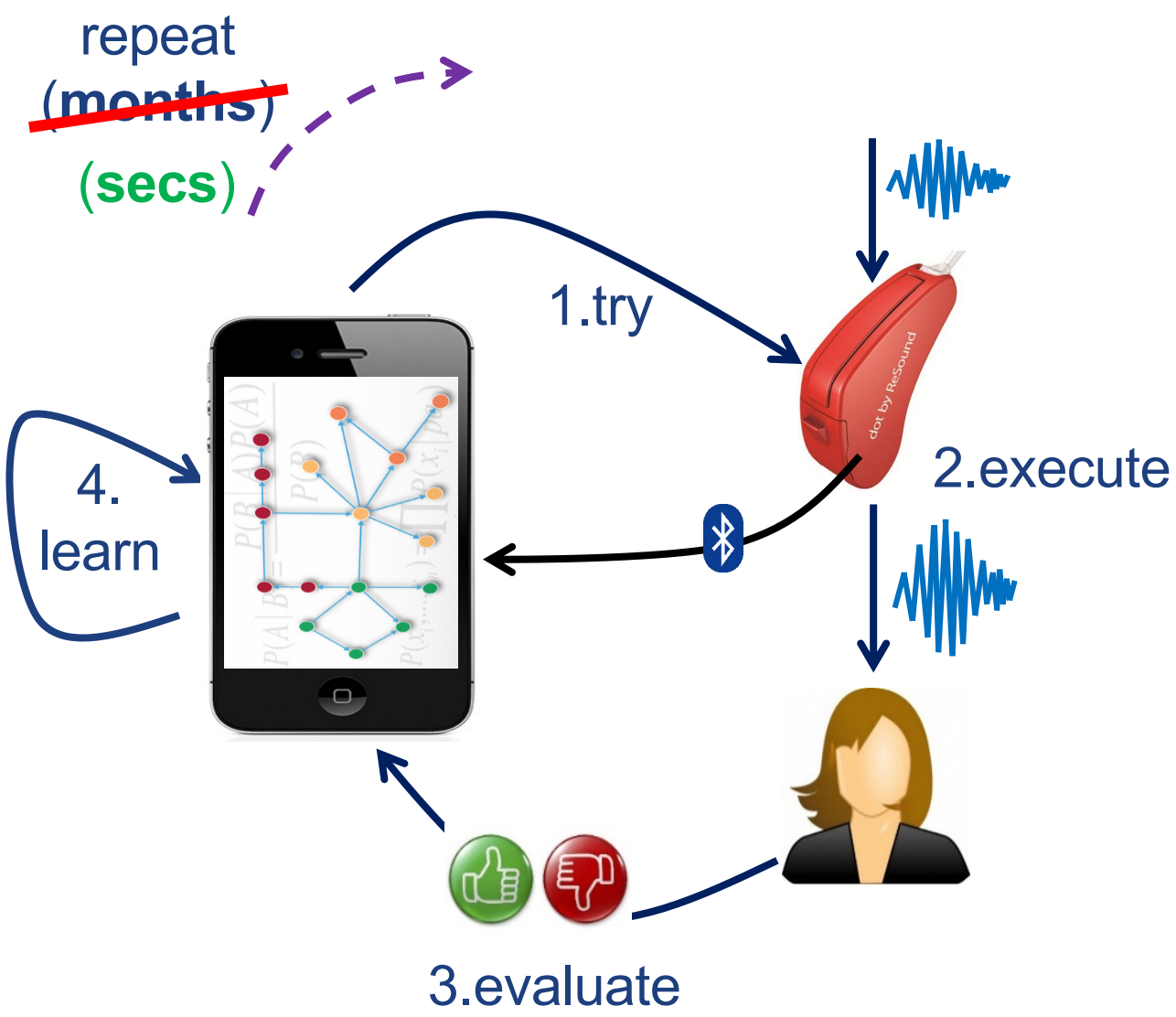


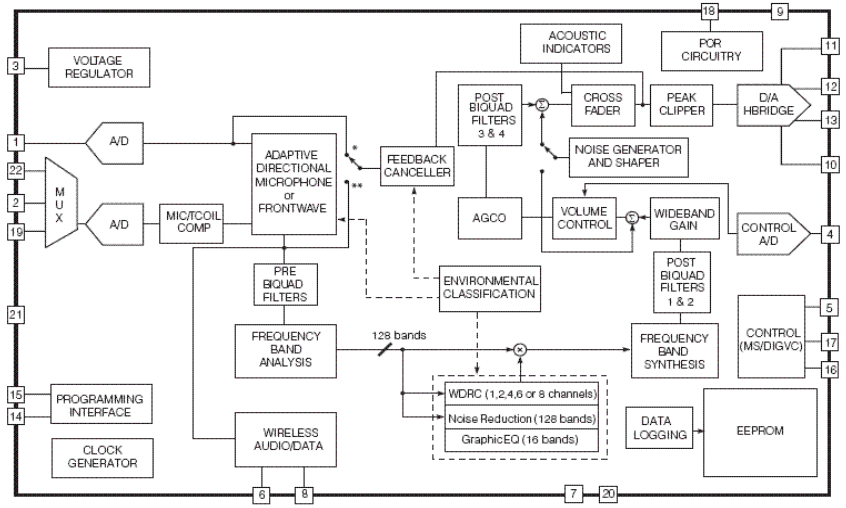
Hearing personalization is *fundamentally* a situated learning problem

From Offline to Situated HA Design

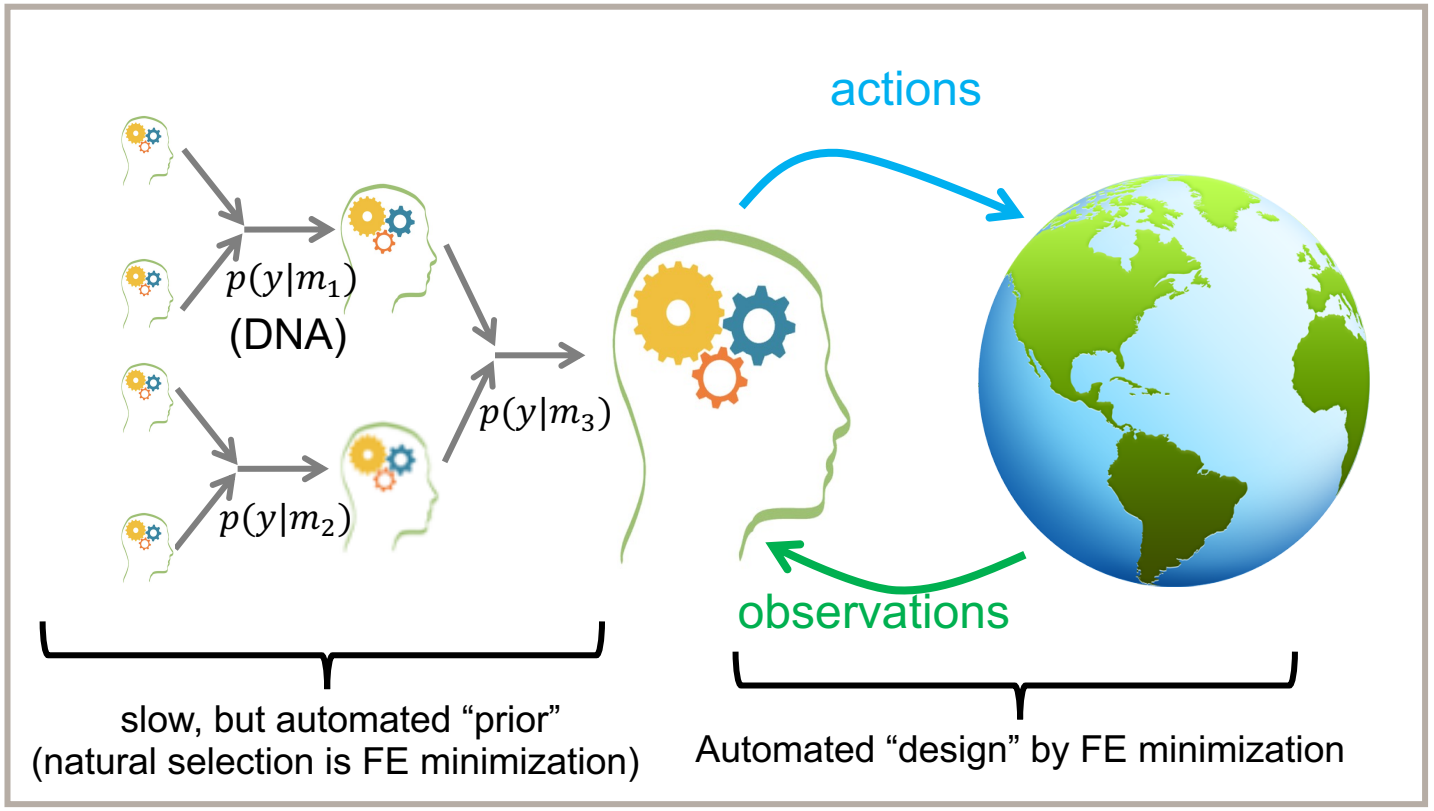


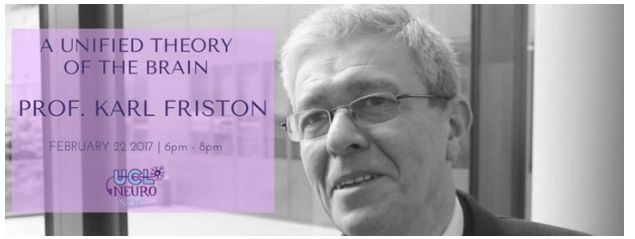
Hearing personalization is *fundamentally* a situated learning problem

“intelligent” design	natural design
slow iterations	multiple timescales (down to real-time)
one problem, many solutions	one solution approach to all problems
involves lots of minds	automated



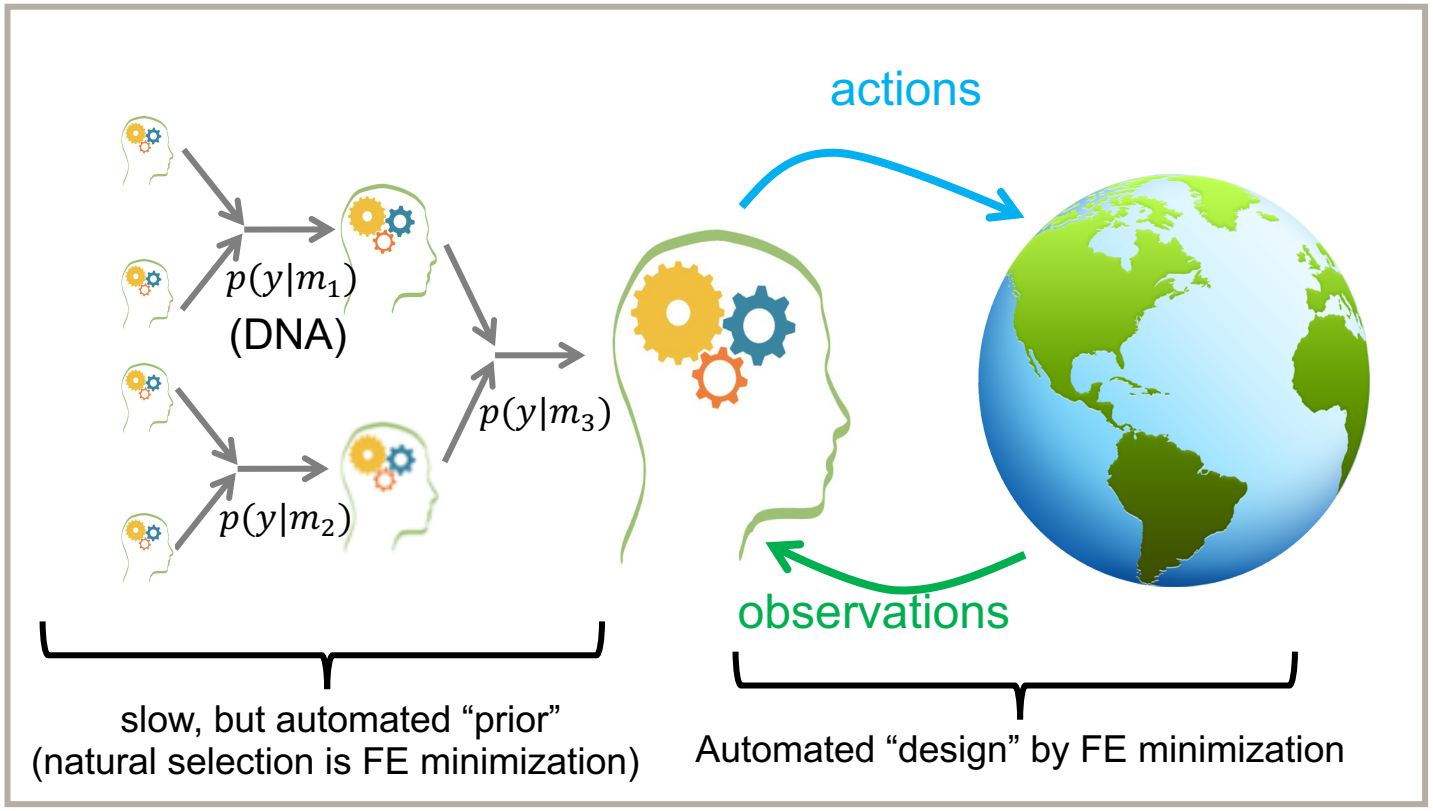
Automated design by FE Minimization in Nature

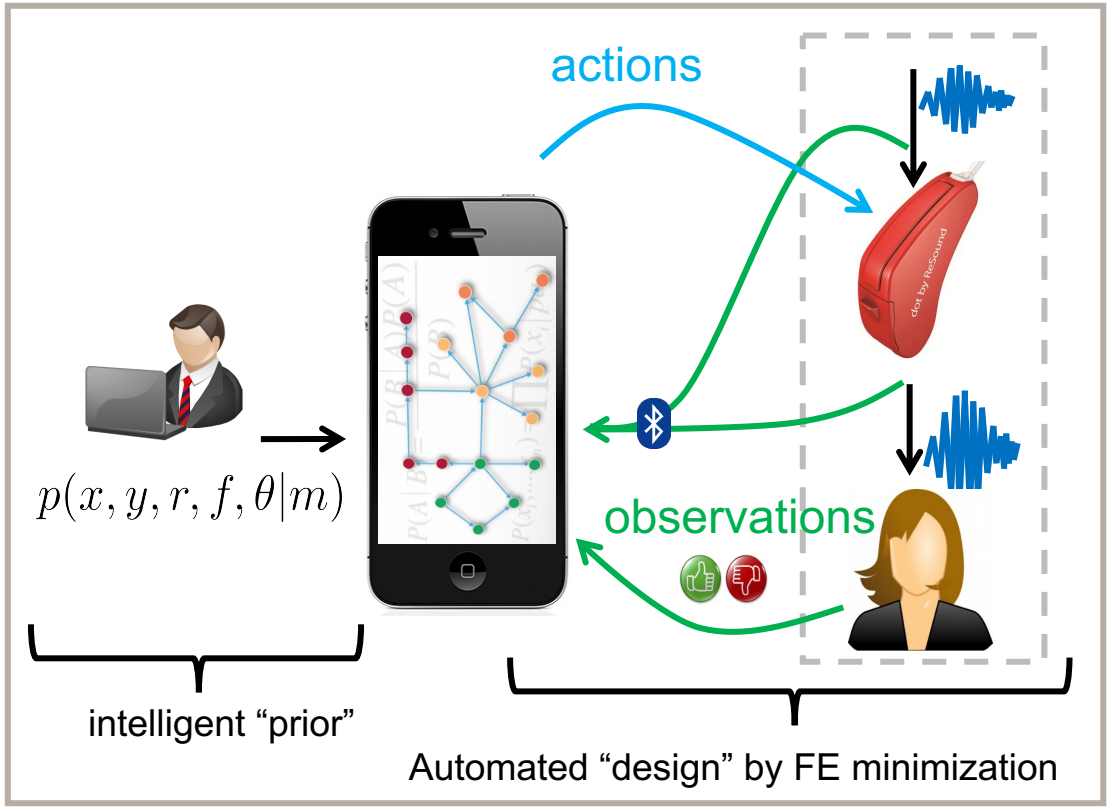




- Karl Friston: Brains do (survive by) free energy minimization (and nothing else)
- All biological self-organization is free energy minimization
- Free energy minimization is just following Hamilton's Principle of Least Action (and therefore is automated)
- Interestingly, following physical law (PLA) is sufficient to design (approximately Bayesian) intelligent agents

Automated design by FE Minimization in Nature and Engineering





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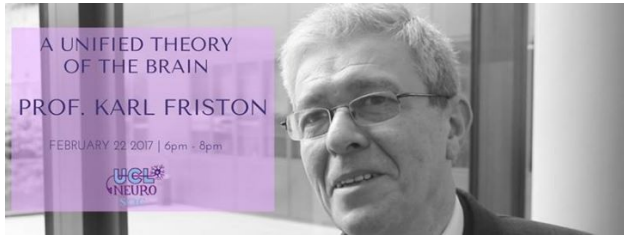
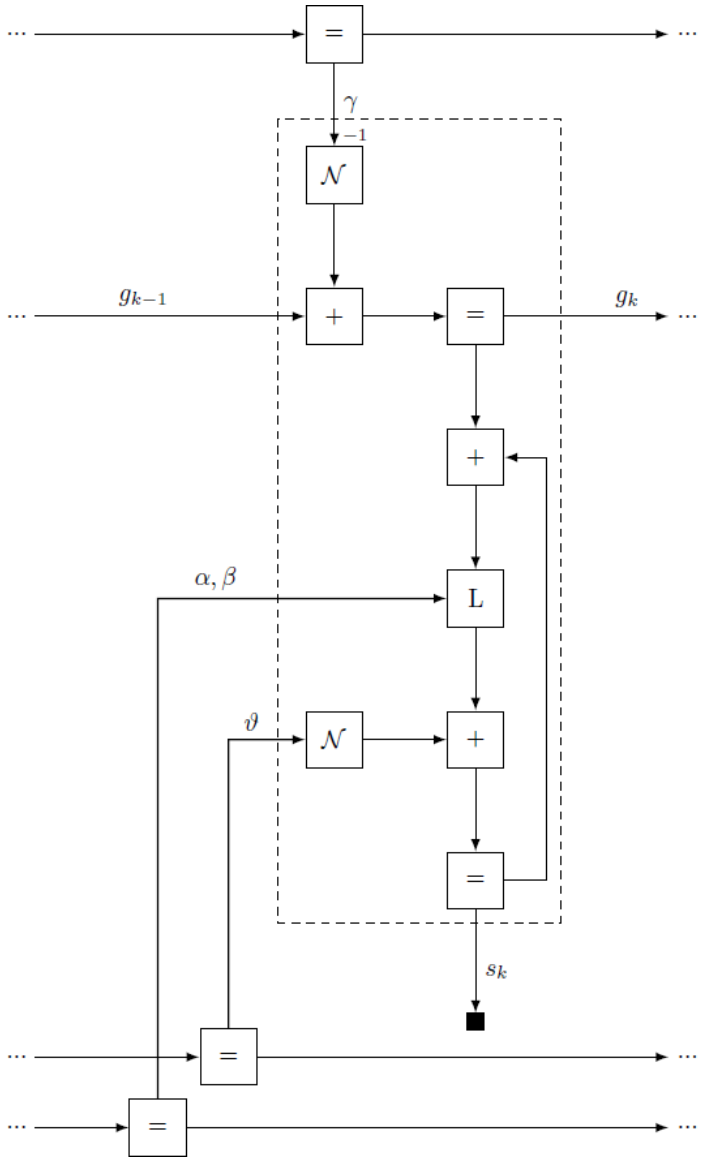
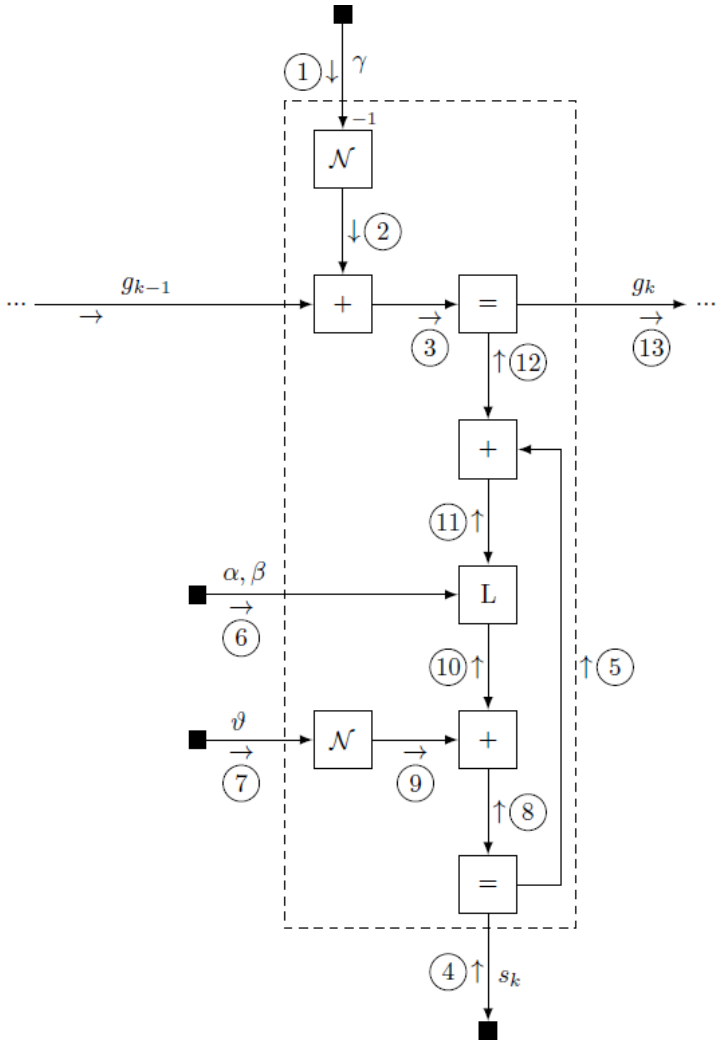


Hearing Loss Compensation by (Variational) Message Passing

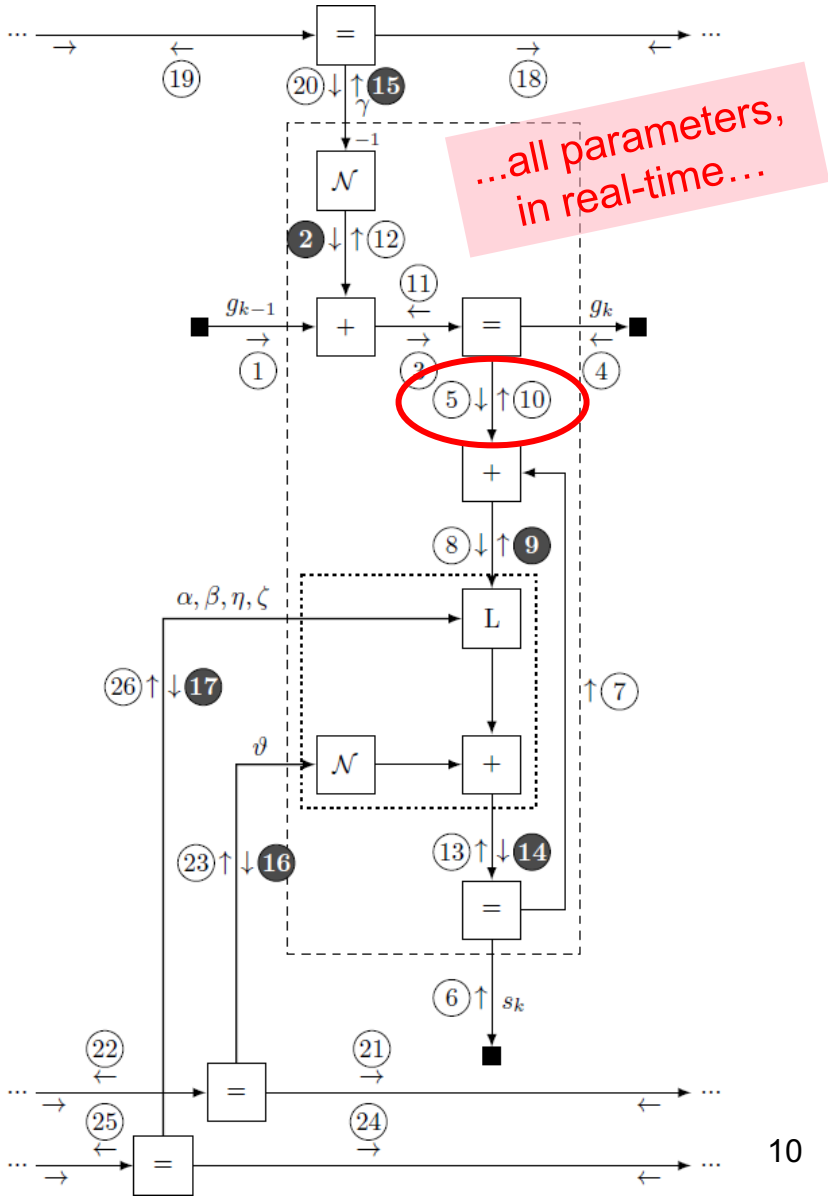
model



signal processing



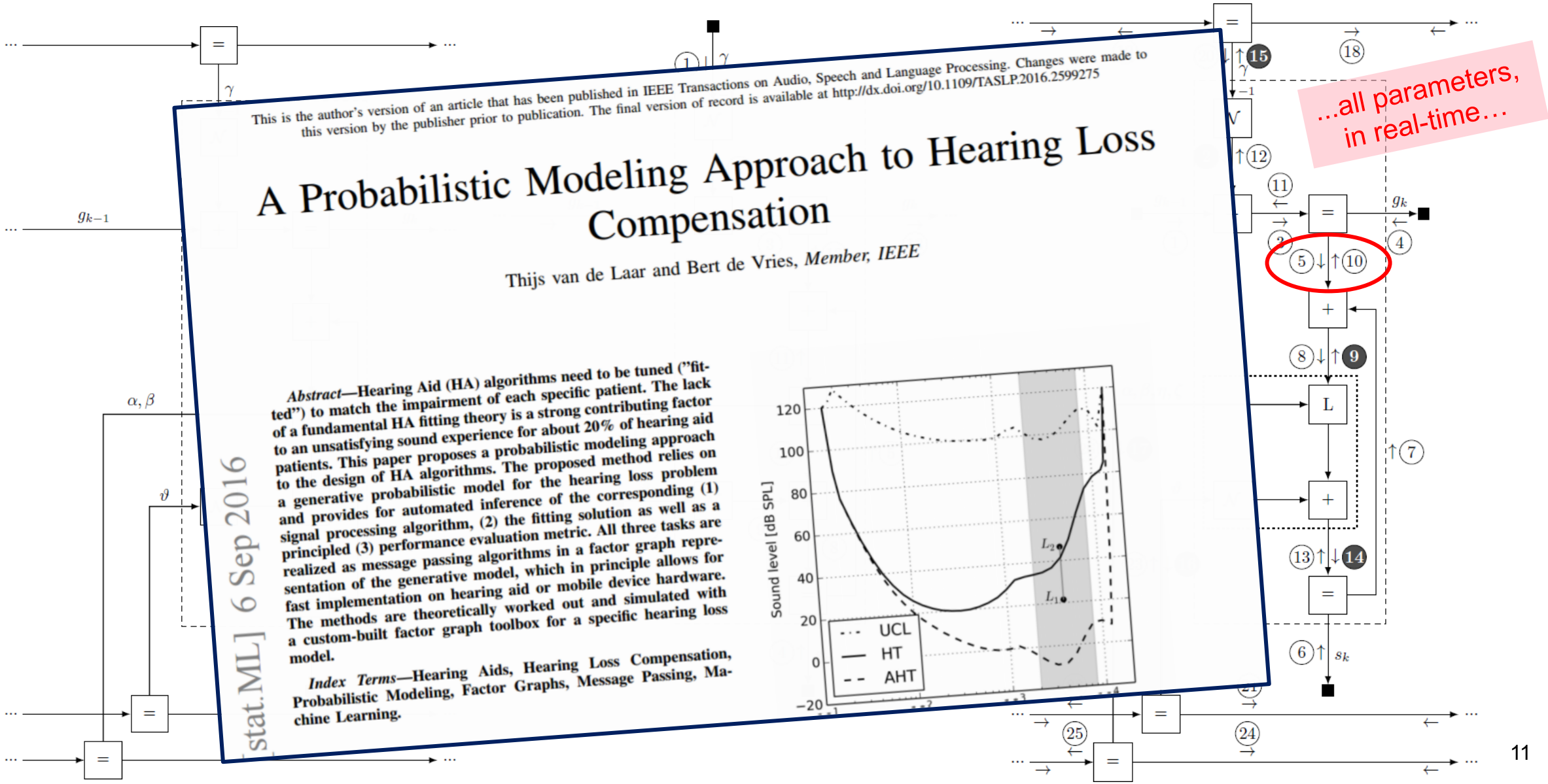
learning



...all parameters, in real-time…

Hearing Loss Compensation by (Variational) Message Passing

model signal processing learning



A Probabilistic Modeling Approach to Hearing Loss Compensation

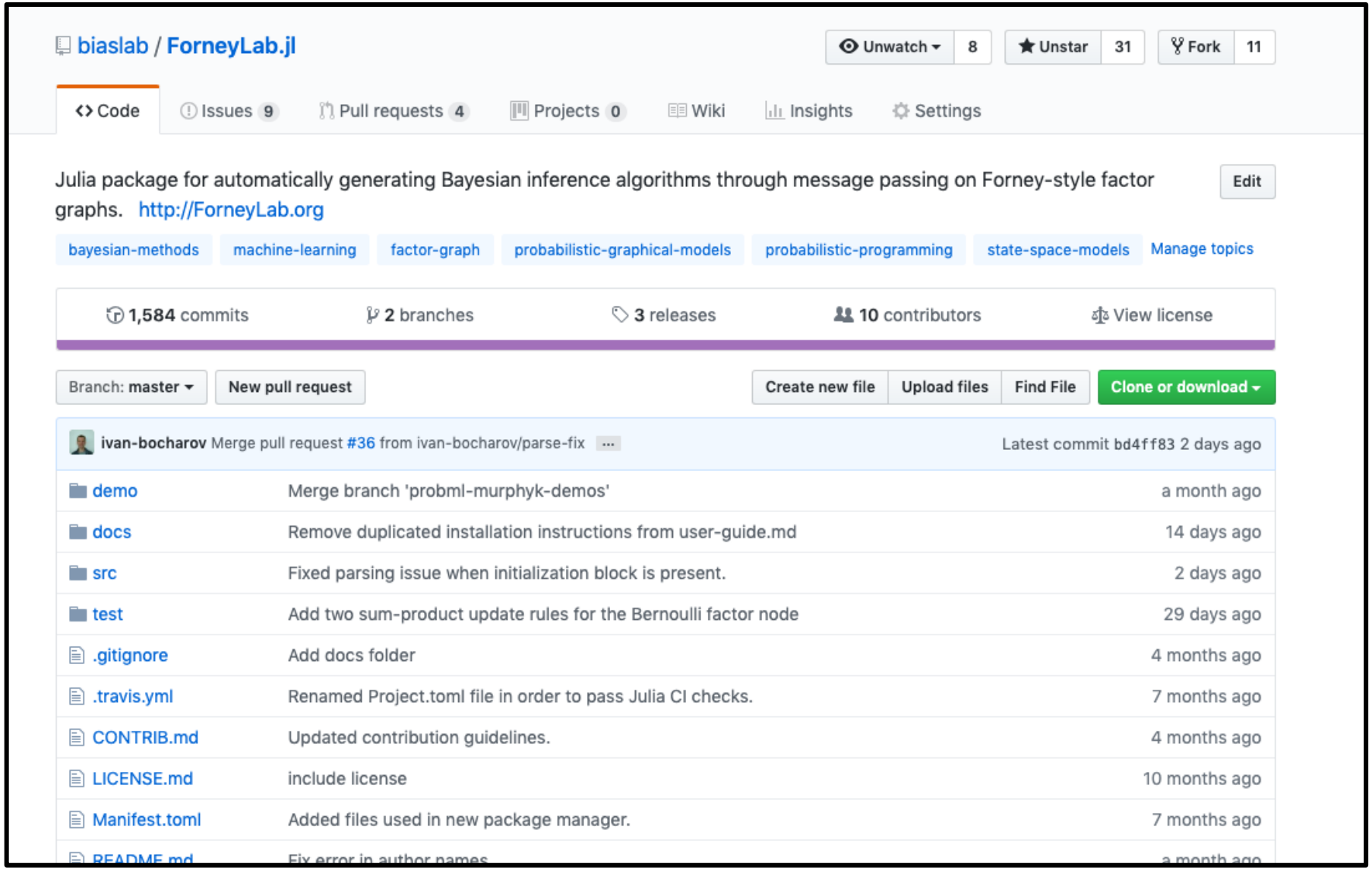
Thijs van de Laar and Bert de Vries, *Member, IEEE*

***Abstract*—Hearing Aid (HA) algorithms need to be tuned ("fitted") to match the impairment of each specific patient. The lack of a fundamental HA fitting theory is a strong contributing factor to an unsatisfying sound experience for about 20% of hearing aid patients. This paper proposes a probabilistic modeling approach to the design of HA algorithms. The proposed method relies on a generative probabilistic model for the hearing loss problem and provides for automated inference of the corresponding (1) signal processing algorithm, (2) the fitting solution as well as a principled (3) performance evaluation metric. All three tasks are realized as message passing algorithms in a factor graph representation of the generative model, which in principle allows for fast implementation on hearing aid or mobile device hardware. The methods are theoretically worked out and simulated with a custom-built factor graph toolbox for a specific hearing loss model.**

***Index Terms*—Hearing Aids, Hearing Loss Compensation, Probabilistic Modeling, Factor Graphs, Message Passing, Machine Learning.**

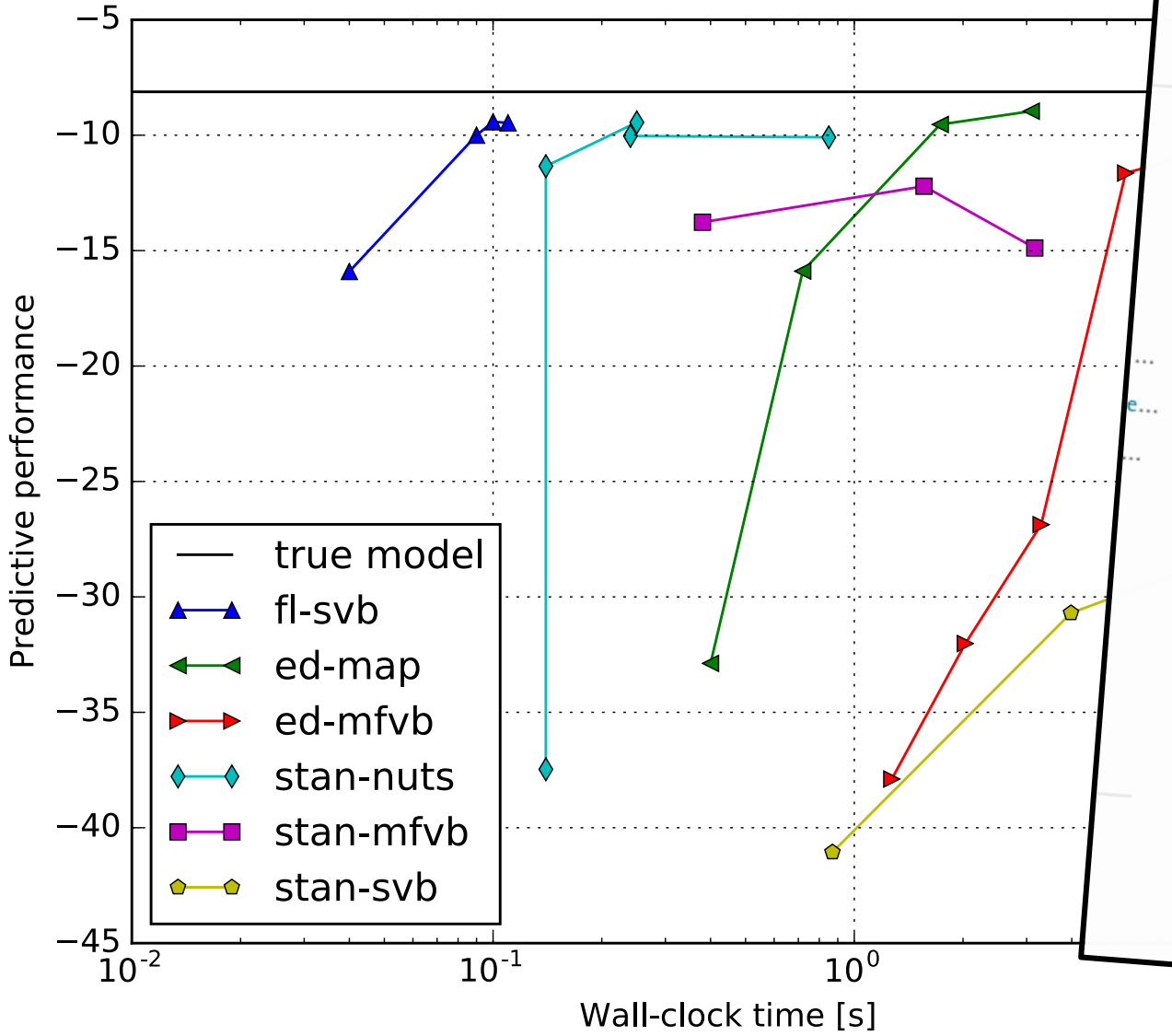
...all parameters, in real-time…

ForneyLab



https://github.com/biaslab/ForneyLab.jl

ForneyLab Performance



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International Journal of Approximate Reasoning

Volume 104, January 2019, Pages 185-204

A factor graph approach to automated design of Bayesian signal processing algorithms

Marco Cox [a] [1], Thijs van de Laar [a] [1], Bert de Vries [a, b]

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https://doi.org/10.1016/j.ijar.2018.11.002

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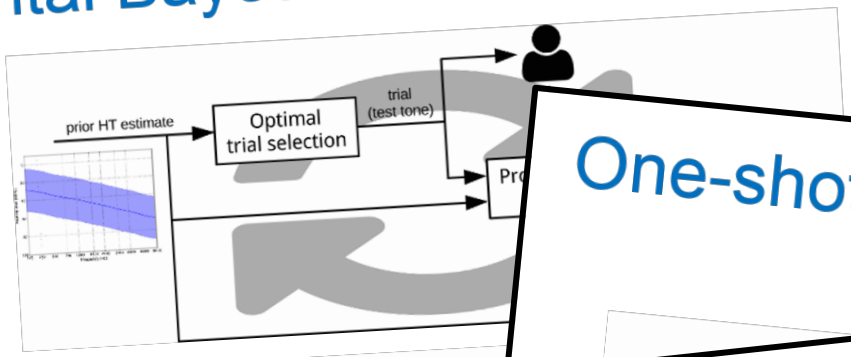
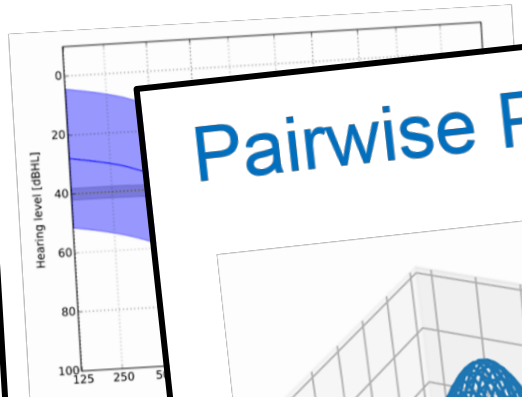
Abstract

The benefits of automating design cycles for Bayesian inference-based algorithms are becoming increasingly recognized by the machine learning community. As a result, interest in probabilistic

Incremental Bayesian Pure-tone Audiometry

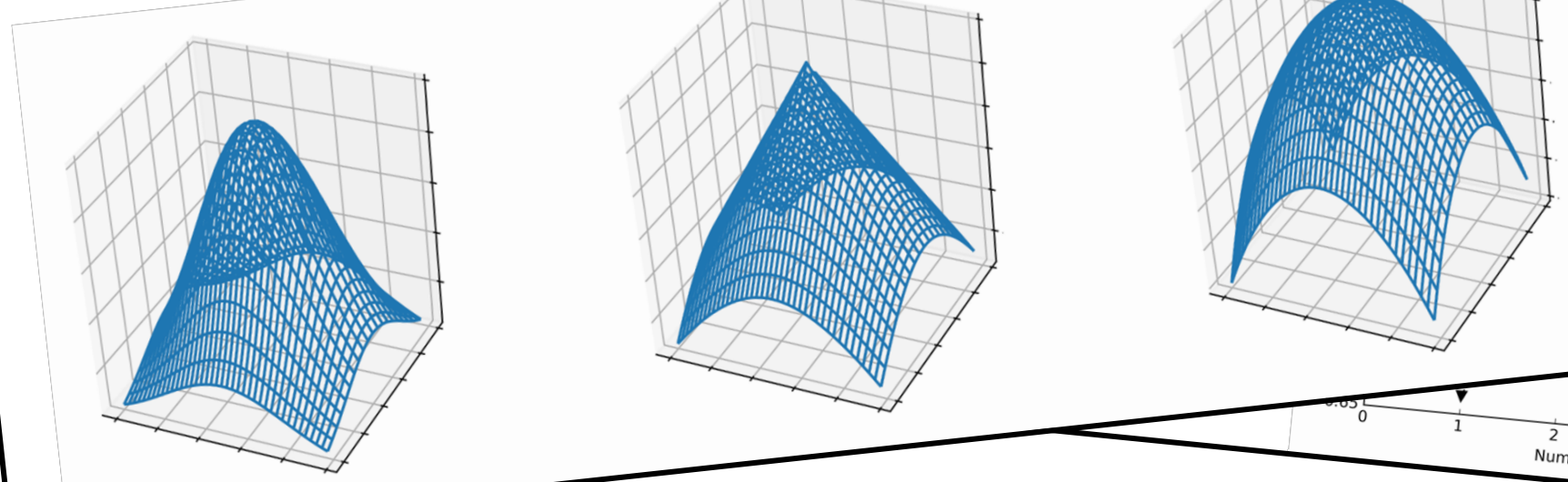


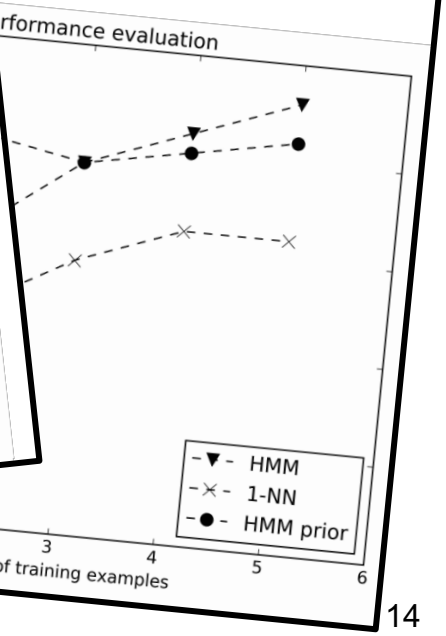


(a) A

One-shot Gesture Recognition

Pairwise Preference-based Bayesian Optimization





Applications

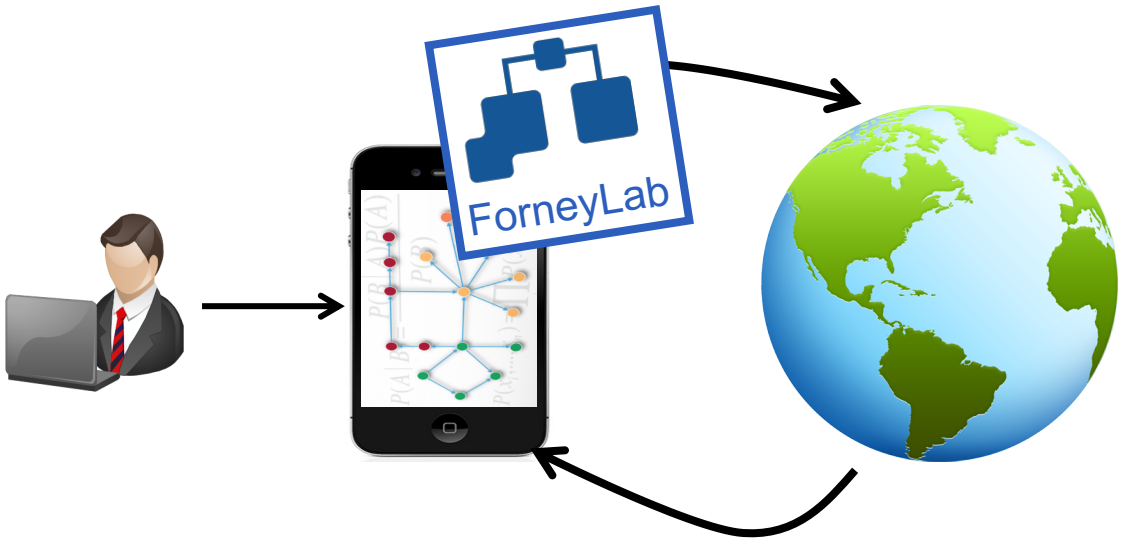
BIASlab mission

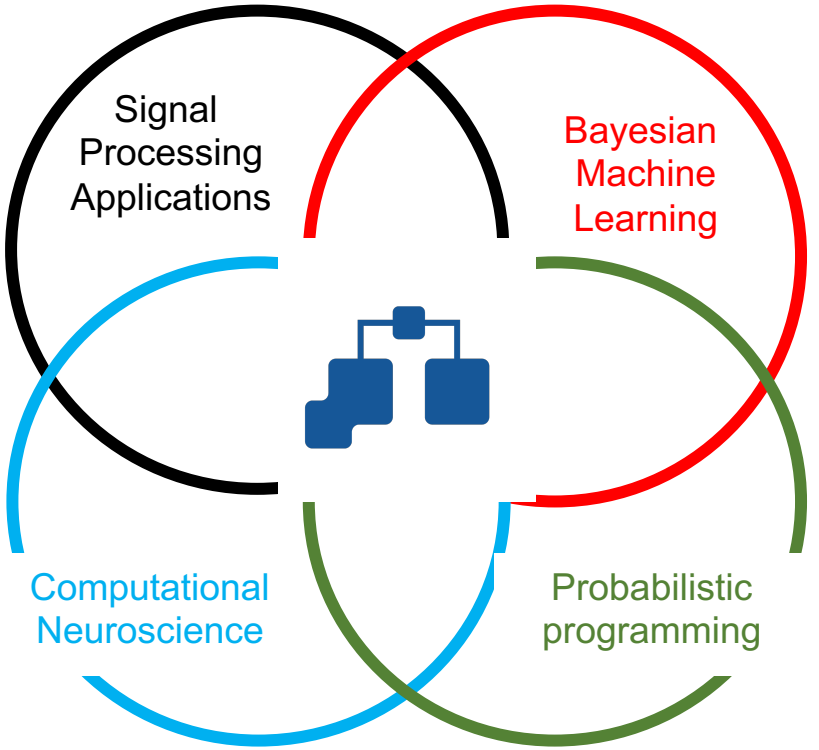
(1) Developing autonomous agents that learn from their environment …

Solution: probabilistic model design by engineer

(2) Using these agents to develop novel signal processing systems

Solution: Automated inference by FEM





Thank you