#57 Responsible Algorithmics: On the Ethics of Machine Learning in Neuroscience

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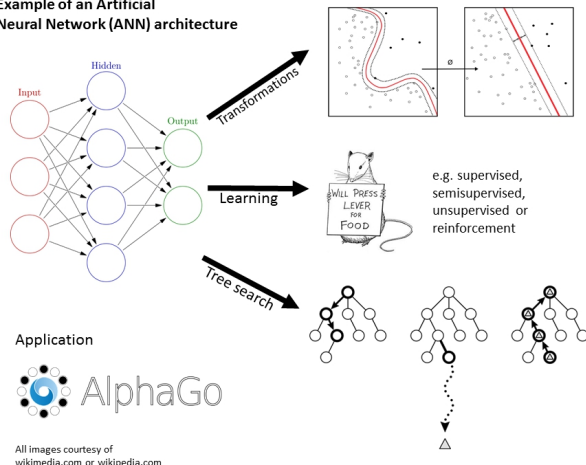
BrainLinks BrainTools
acting.thoughts

Main points

❖ Machine learning algorithms, particularly artificial neural networks for **deep learning**, are increasingly used for research and clinical applications in neuroscience
❖ The increased decision-making capacity of intelligent systems may create an **accountability gap**
❖ Human values, biases and prejudices – basic **human fallibility** – may be transferred to algorithms and robots
❖ Devices based on machine learning may be vulnerable to **hacking** or other **malicious interaction** with third parties
❖ Having responsible humans train algorithms – **"digital parenting"** – may prevent misuse and enhance safety
❖ Inscrutability of the algorithms' decision pathways and diminished human accountability may create **regulatory gaps**
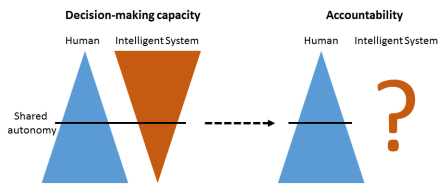❖ Regulatory guidance and laws for the licensing of medicinal products with machine learning should be reviewed

What is machine learning?

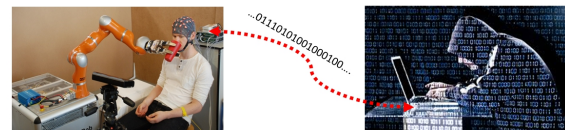**Example of an Artificial Neural Network (ANN) architecture**

e.g. supervised, semisupervised, unsupervised or reinforcement

Application

AlphaGo

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Machine learning in neuroscience

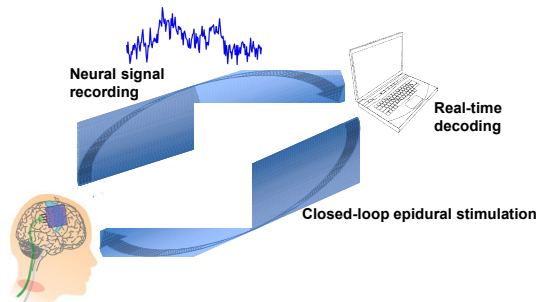❖ **Classifying and predicting: Precision medicine**

Image classification: Diabetic retinopathy, small-cell lunger cancer, normal vs. pathological lymph nodes

Neuroimaging as biomarker: Alzheimer's dementia [1], Parkinson's disease vs. atypical Parkinson syndromes

Prediction: Predicting outcome after stroke, predicting severity and persistence of depressive symptoms [2] or outcome in psychosis [3]

❖ **Analysing and intervening: Predictive brain implants**

Closed-loop brain-computer interface (BCI)

Neural signal recording

Real-time decoding

Closed-loop epidural stimulation

Other examples: insulin pumps, deep brain stimulation for Parkinson's disease [4]

Ethical challenges from machine learning

❖ **Mind the accountability gap** [5,6]

Decision-making capacity — Human, Intelligent System
Accountability — Human, Intelligent System
Shared autonomy

❖ **Safety and privacy of neural data**

...0110101001000100...

❖ **The human fallibility trap and "digital parenting"** [7]

Data
Programmer(s)
Biases
main( ) {
    printf("hello, world");
}
Algorithm
User(s)
I'm so biased
Intelligent System

Recent examples:
- Microsoft's racist chatbot Tay (2016)
- Algorithm for judging beauty contest has racial bias (Guardian, 9/2016)
- Predictive policing perpetuates biases (Guardian, 8/2016)

Regulatory aspects

❖ **Regulatory gaps for machine learning applications**
Regulatory bodies (FDA, EMA) are struggling to keep up with innovations in computer science leading to a *patchwork of guidance and laws*

❖ **Top-down vs. bottom-up models of regulation**
Top-down: Governance relies on expert opinions ("expertocracy"), discussions behind "closed doors"

Bottom-up: The "deliberative turn" in democratic theory emphasises the importance of the public sphere and **participatory models** of political-decision making as indicators for *good governance*

References

[1] Pekkala T, Hall A, Lötjönen J, Mattila J, et al.. Development of a Late-Life Dementia Prediction Index with Supervised Machine Learning in the Population-Based CAIDE Study. J Alzheimers Dis. 2016 Oct 14.
[2] Kessler RC, van Loo HM, Wardenaar KJ, et al. Testing a machine-learning algorithm to predict the persistence and severity of major depressive disorder from baseline self-reports. Mol Psychiatry. 2016 Oct;21(10):1366-71.
[3] Young J, Kempton MJ, McGuire P. Using machine learning to predict outcomes in psychosis. Lancet Psychiatry. 2016 Oct;3(10):908-909.
[4] Shamir RR, Dolber T, Noecker AM, Walter BL, McIntyre CC.. Machine Learning Approach to Optimizing Combined Stimulation and Medication Therapies for Parkinson's Disease.. Brain Stimul. 2015 Nov-Dec;8(6):1025-32.
[5] Kellmeyer P, Cochrane T, Müller O, Mitchell C, Ball T, Fins JJ, Biller-Andorno N. The Effects of Closed-Loop Medical Devices on the Autonomy and Accountability of Persons and Systems. . Camb Q Healthc Ethics. 2016 Oct;25(4):623-33.
[6] see also: Kellmeyer P. "Mind the accountability gap: on the ethics of shared autonomy between humans and intelligent medical devices". Practical Ethics blog, University of Oxford, October 7th 2016: http://blog.practicalethics.ox.ac.uk/2016/10/guest-post-mind-the-accountability-gap-on-the-ethics-of-shared-autonomy-between-humans-and-intelligent-medical-devices/
[7] see also: Kellmeyer P. "On the ethics of machine learning applications in clinical neuroscience". The Neuroethics Blog, November 8th 2016. http://www.theneuroethicsblog.com/

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