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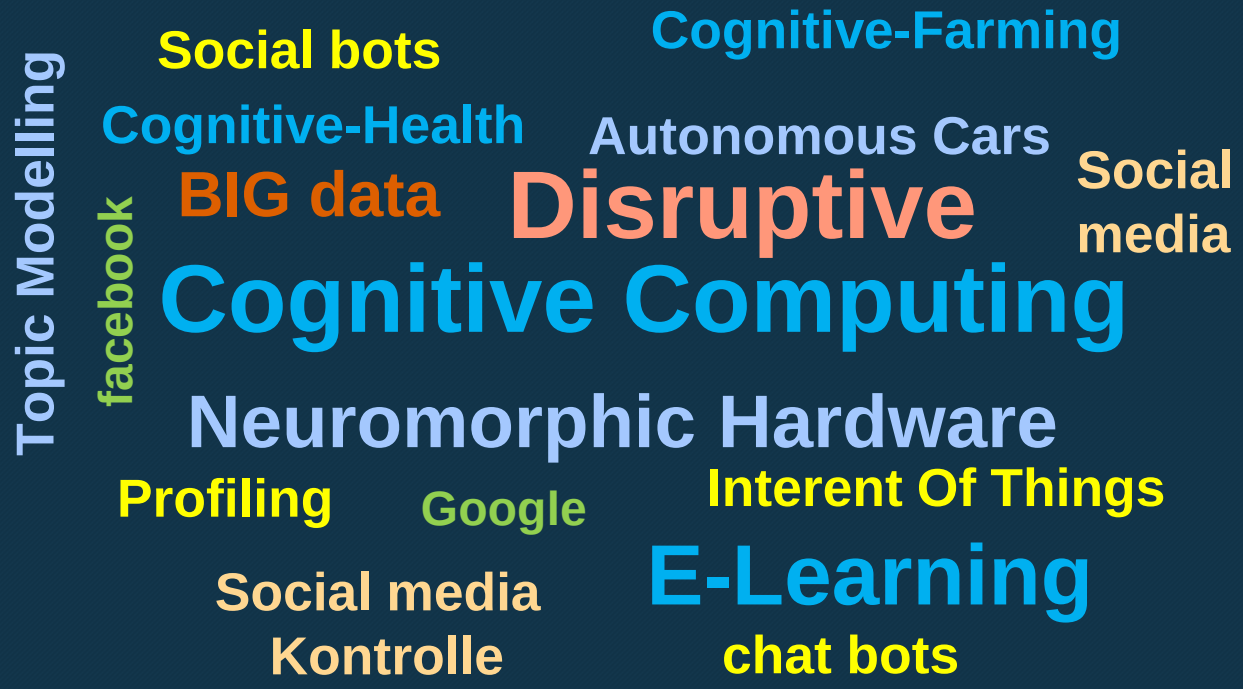
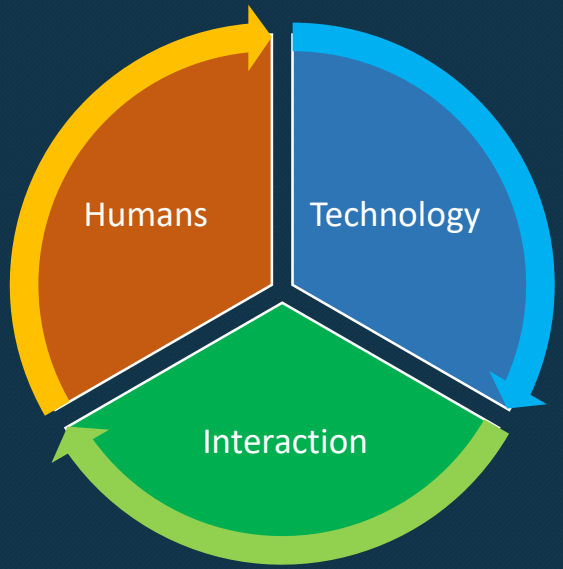
UNIVERSITÄT OSNABRÜCK



Cognitive Computing – (The new AI)



Symbiotic fusion of the intelligent system, the user, and the expert.

Dialog between machine and human (natural language, intuitive graphics, and gestures)

The machine is the super assistant that enables the human to make truly intelligent decisions in complex scenarios.

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At the core of Cognitive Computing since 15 years

11 full professors

~ 600 BSc
~ 200 MSc
~ 45 PhD students

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Cognitive Computing to predict and manage infectious outbreaks

Prof. Dr. Gordon Pipa, Osnabruck University

Prof. Dr. Kai-Uwe Kühnberger, Osnabruck University

Prof. Dr. Dr. Bertram Scheller, University Hospital Frankfurt

UNIVERSITÄTS KLINIKUM FRANKFURT
GOETHE-UNIVERSITÄT

Relevance of Cognitive Computing

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„For the ***Robert Koch Institute*** the machine learning and cognitive computing are very important topics for the future. The project ***flu-prediction*** of university Osnabrück demonstrates and highlights the huge potential of these technologies for public health“

ROBERT KOCH INSTITUT

Assessment by
Prof. Dr. Lothar H. Wieler
President of the
Robert Koch Institute

www.flu-prediction.com

Institute of Cognitive Science

Influenza matters

Prediction is important

Delayed and too little data

Data science methods

Social media analysis

Watson as medical expert

Cognitive Computing

flu prediction

A one year project by a core team of three master's students

www.flu-prediction.com

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Better prediction

Fully informed user

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Structured Causal Models

flu prediction

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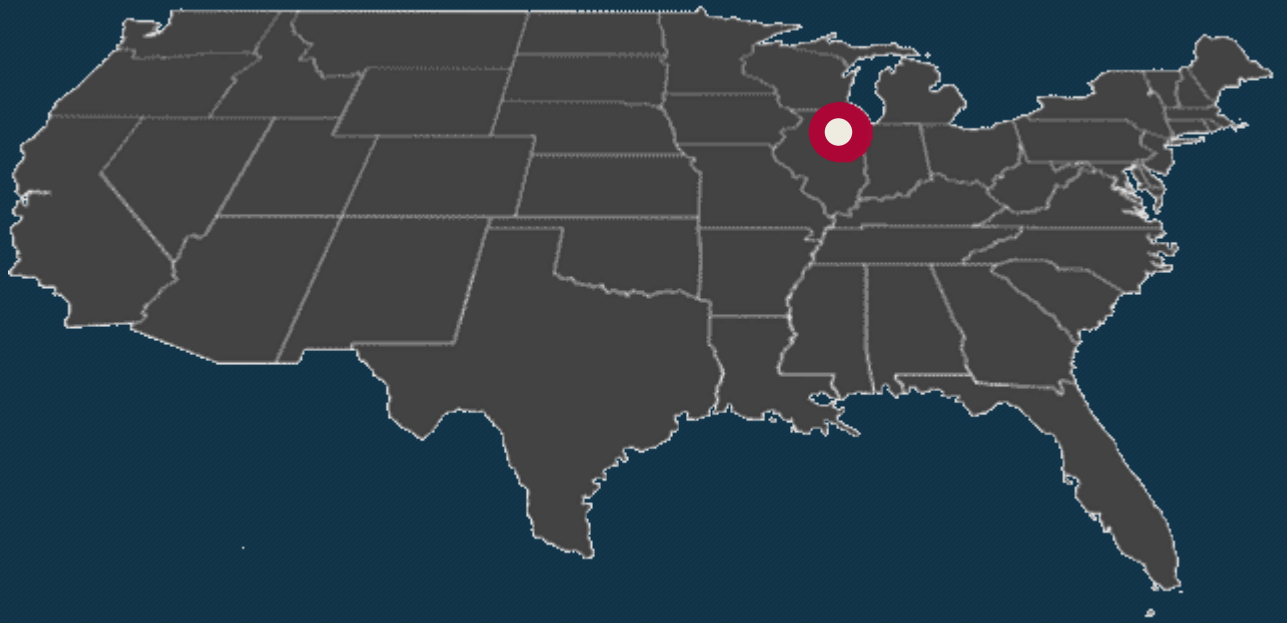

- **Disease spreads locally and via transportation hubs**
- **Weather, vaccination, and seasonal events change spreading**

Structured Causal Models

flu prediction

Institute of Cognitive Science

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flu prediction

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- **Disease spreads locally and via transportation hubs**
- **Weather, vaccination, and seasonal events change spreading**

Structured Causal Models

flu prediction

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Direction and speed of spread NEEDS to be identified from data

U.S. Outpatient Influenza-like Illness Surveillance Network (ILINet)

Identify Causal Interactions

flu prediction

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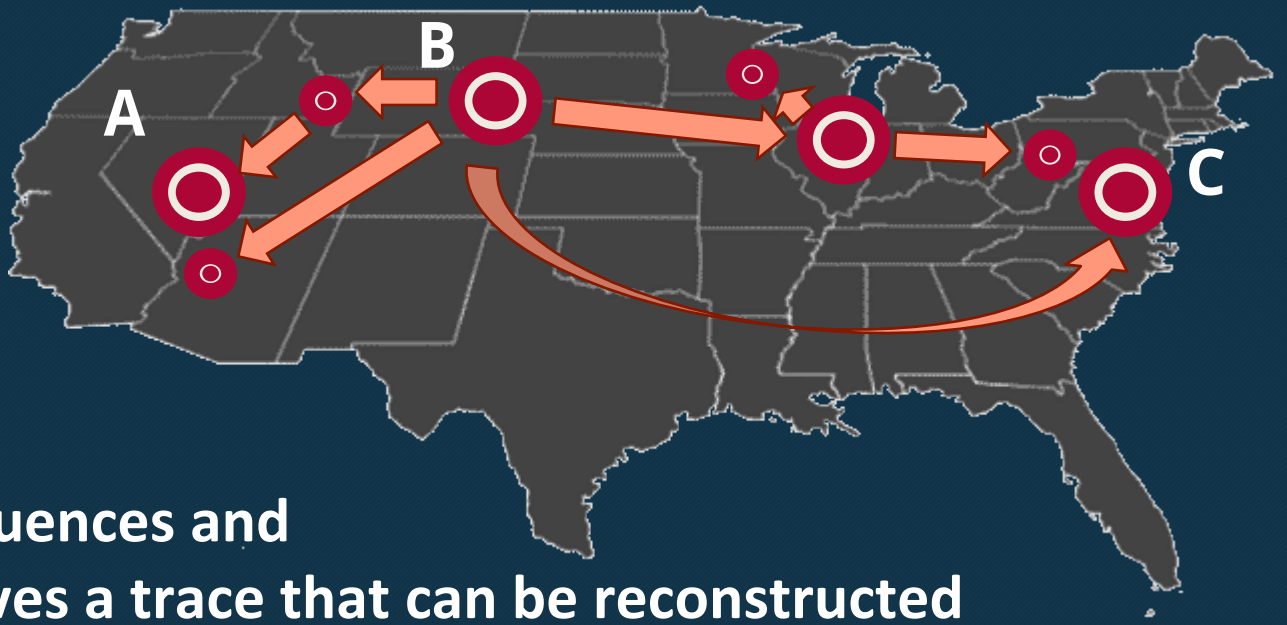

A driver influences and thereby leaves a trace that can be reconstructed

- Schumacher et al. (2015) - A Statistical Framework to Infer Delay and Direction of Information …
- Sugihara et al. (2012) - Detecting Causality in Complex Ecosystems

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Fully informed user

Social Media

flu prediction

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Twitter activity (geo tag + Tweet)

Unstructured Data from 500 Mil tweets a day !

Sample Tweets from 29/09/16

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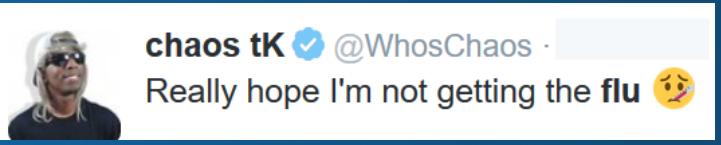
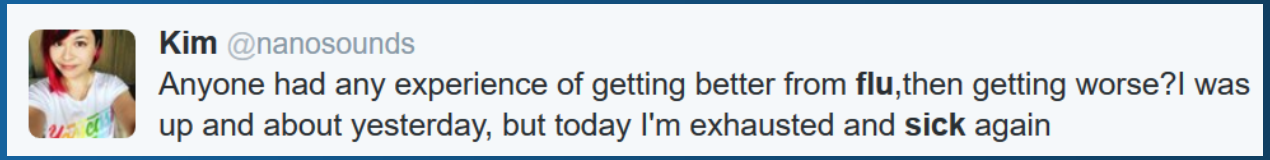
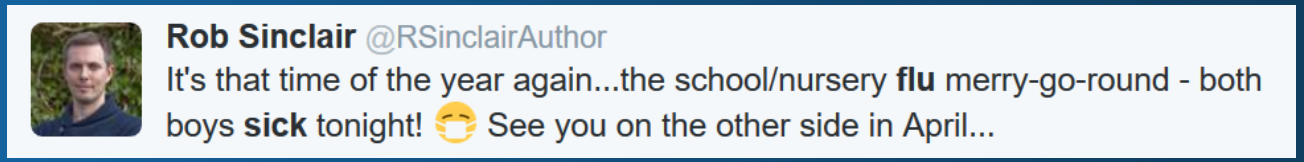


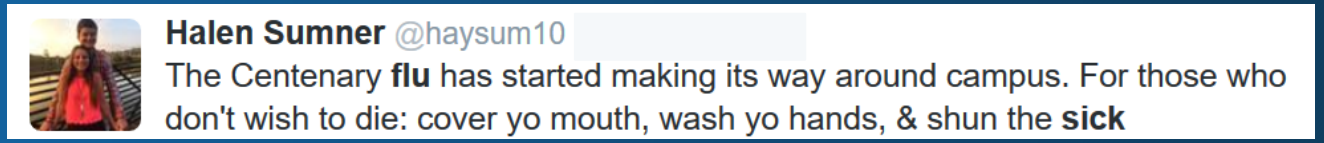
himself worried



herself sick



familiy is sick



friends are sick

Close the Gap by Fusing Data

flu prediction

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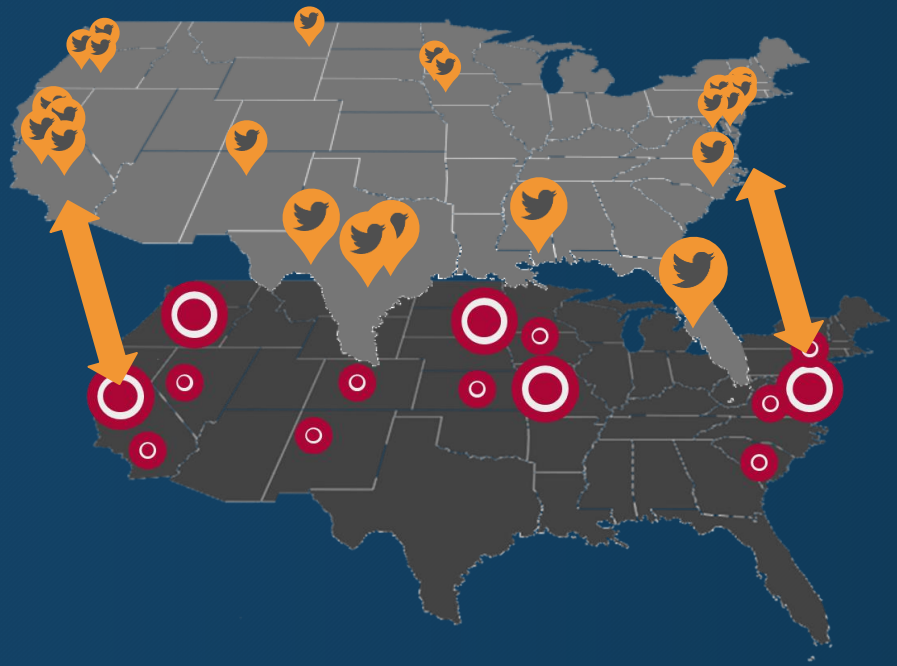
Realtime fuzzy social media

+

Slow but reliable CDC data



Twitter activity (geo tag + Tweet)

CDC – delayed influenza data

Use the best from both worlds to improve prediction

Delay Reduction with Twitter Data

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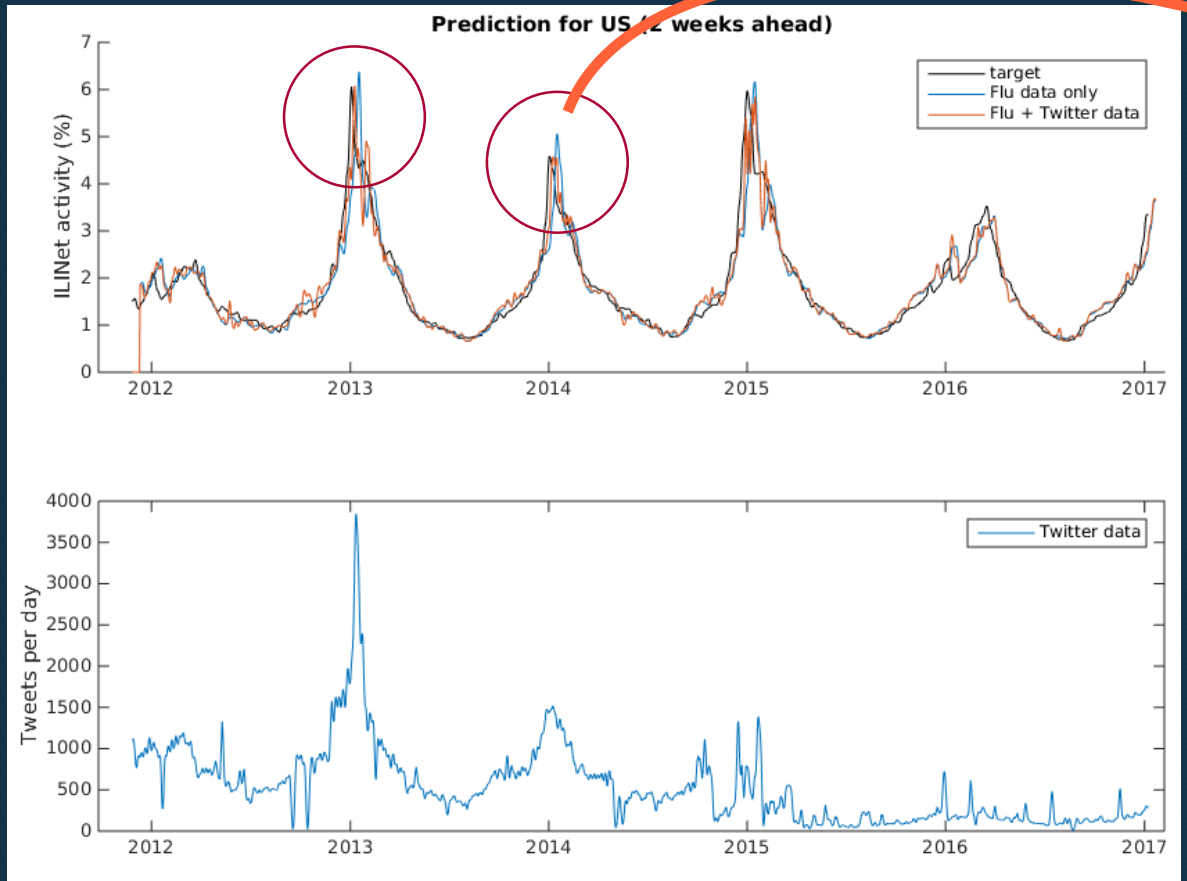

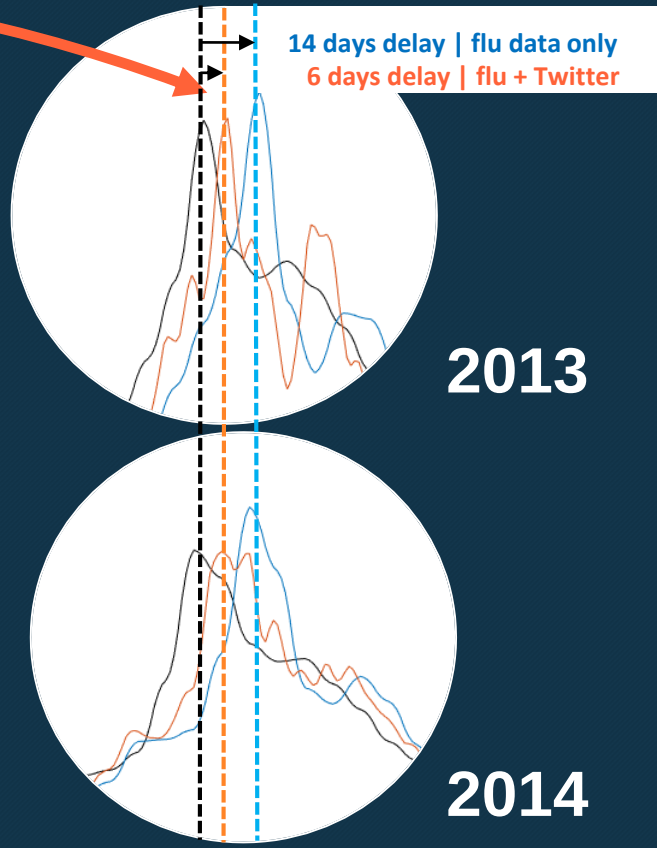

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Better prediction

Fully informed user

Cognitive Computing: Natural Language + Data Science

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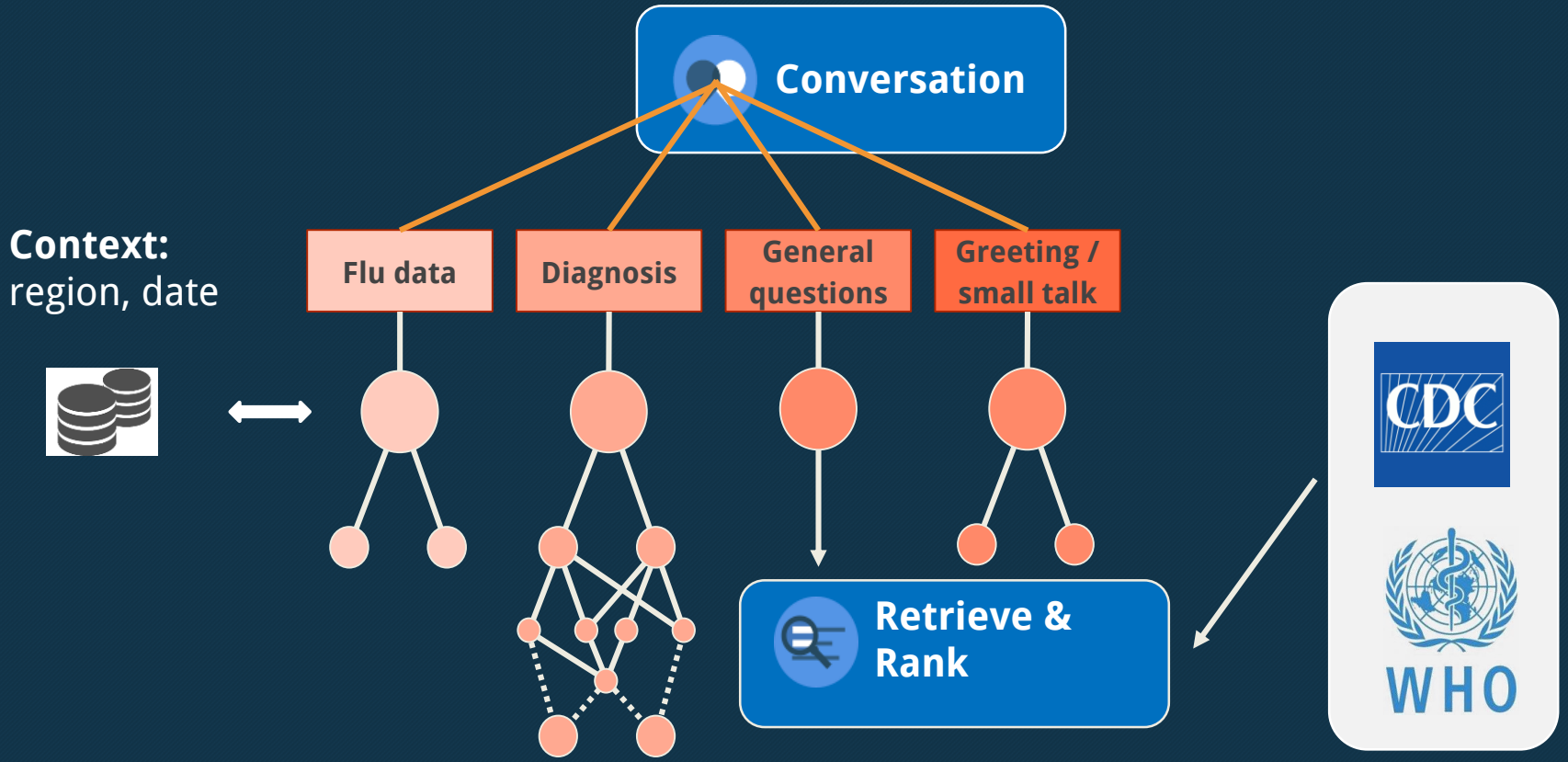

flu prediction

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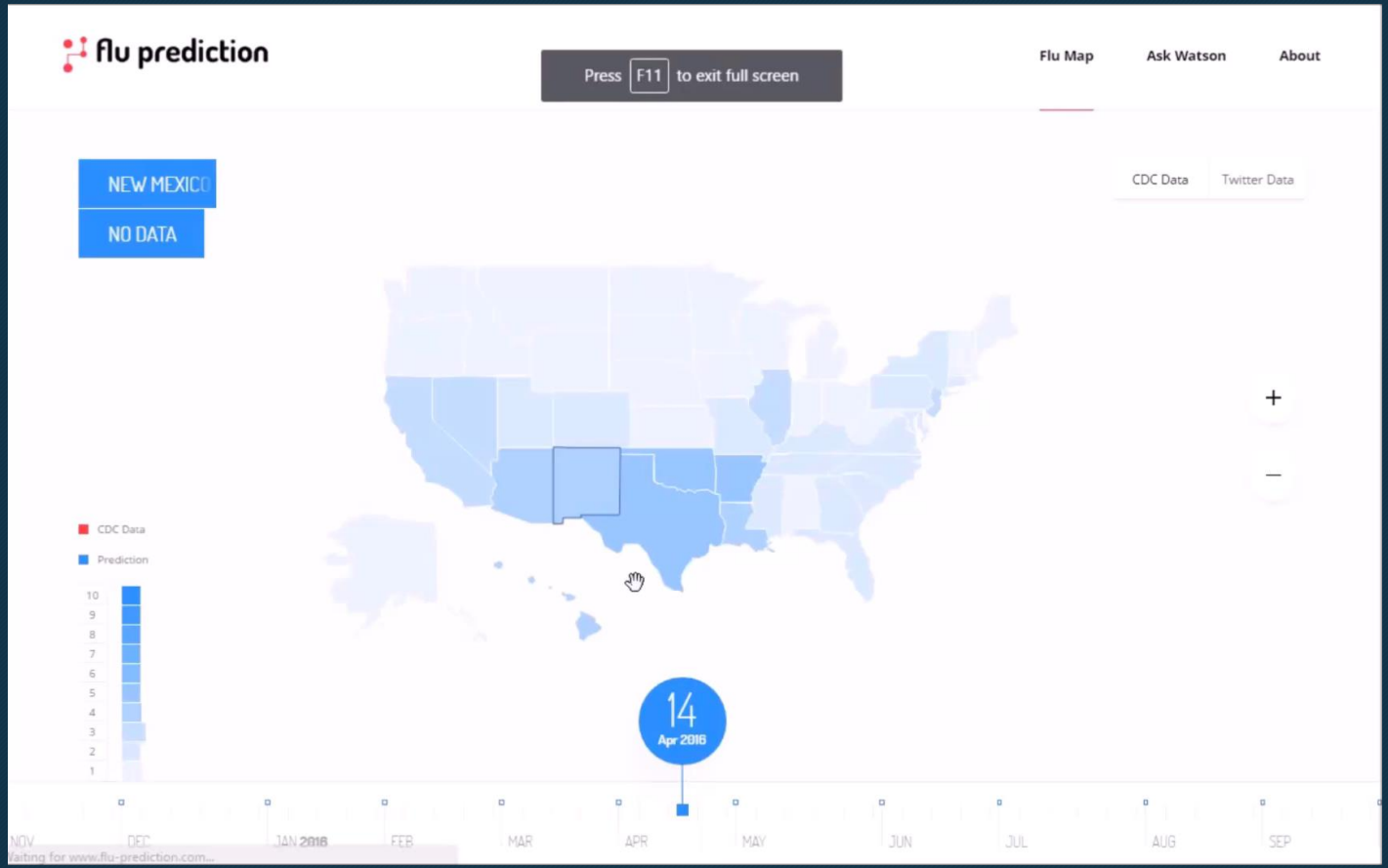

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IBM Academic Initiative

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Speak with Watson Flu

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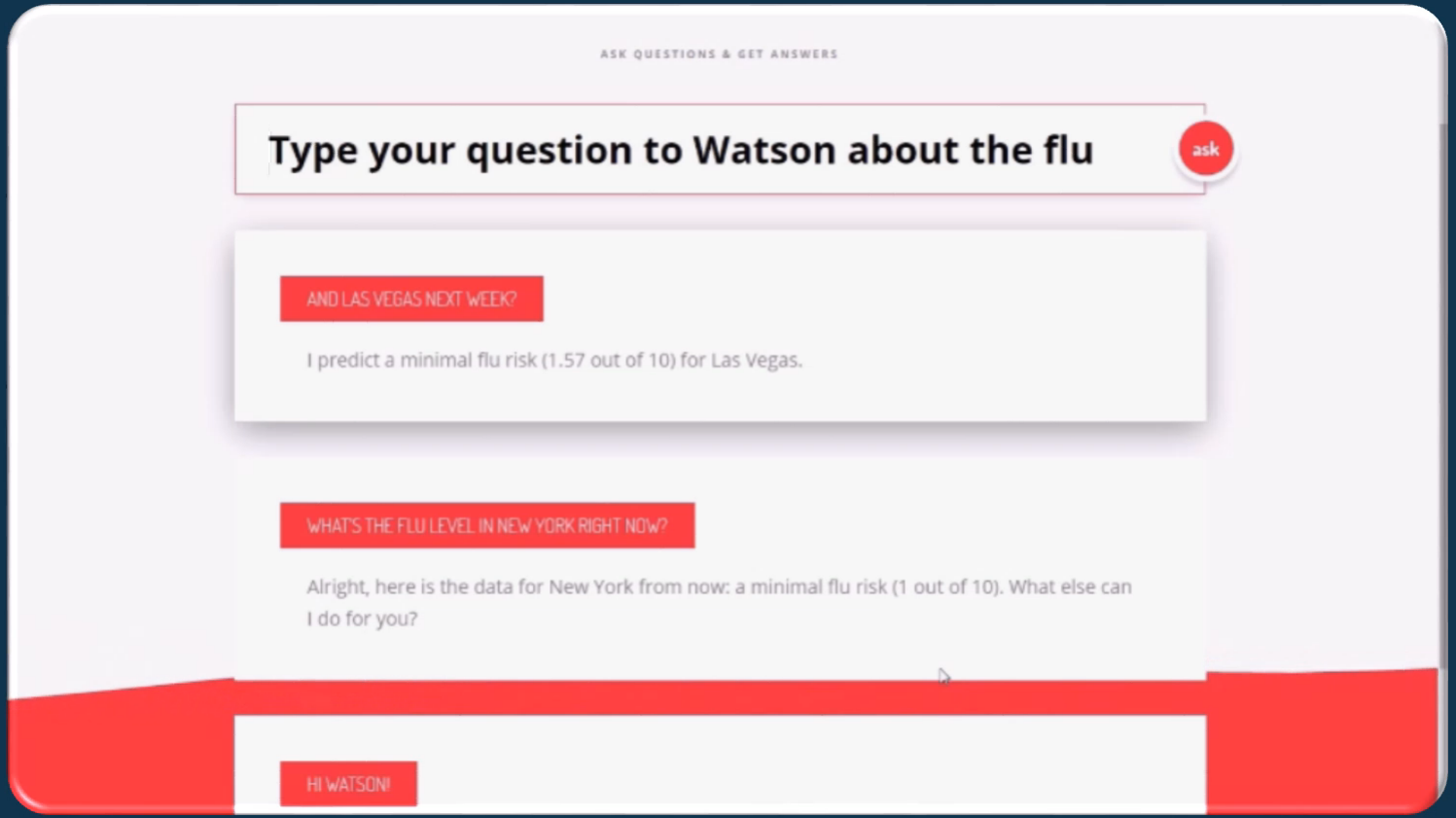

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Summary

flu prediction

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Data science methods

- Data science allows identification of very complex causal relations

Social media analysis

- Combine social media with other conventional data to get the best of both worlds → realtime and reliable

Watson as expert

- Use unstructered data to learn relationships

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Neuromorphic computing

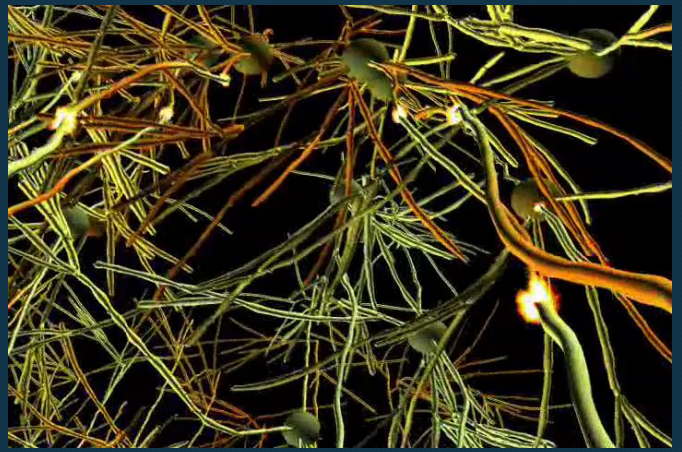
Prof. Dr. Gordon Pipa, Osnabruck University

Neuro-Inspired Hardware

Institute of Cognitive Science

- The cortex is structured canonically
- Cortex learns to process information based on self-organisation and reward based learning
- Cortical computing is robust

Neuronal Netzwork
(© EU Flagship Project HBP)



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- Kovac, Koall, Pipa, Toutounji, “Persistent Memory in Single Node Delay-Coupled Reservoir Computing”, PloS one 11 (10), e0165170 (2016)
- Schumacher, Toutounji, Pipa, “An introduction to delay-coupled reservoir computing”, Artificial Neural Networks, 63-90 (2015)
- Aswolinskiy, Pipa, “RM-SORN: a reward-modulated self-organizing recurrent neural network“, Frontiers in computational neuroscience 9 (2015)
- Toutounji, Schumacher, Pipa, “Homeostatic plasticity for single node delay-coupled reservoir computing”, Neural computation (2015)
- Toutounji, Pipa, “Spatiotemporal computations of an excitable and plastic brain: …”, PLOS CB (2014)
- Lazar, Pipa. Triesch. “SORN: a self-organizing recurrent neural network”, Frontiers in computational neuroscience (2009)

Neuro-Inspired Hardware

Institute of Cognitive Science

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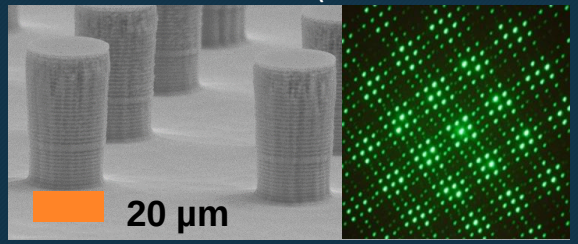
IBM Synapse system

Laser based neurons (***S. Reitzenstein & D. Brunner)***



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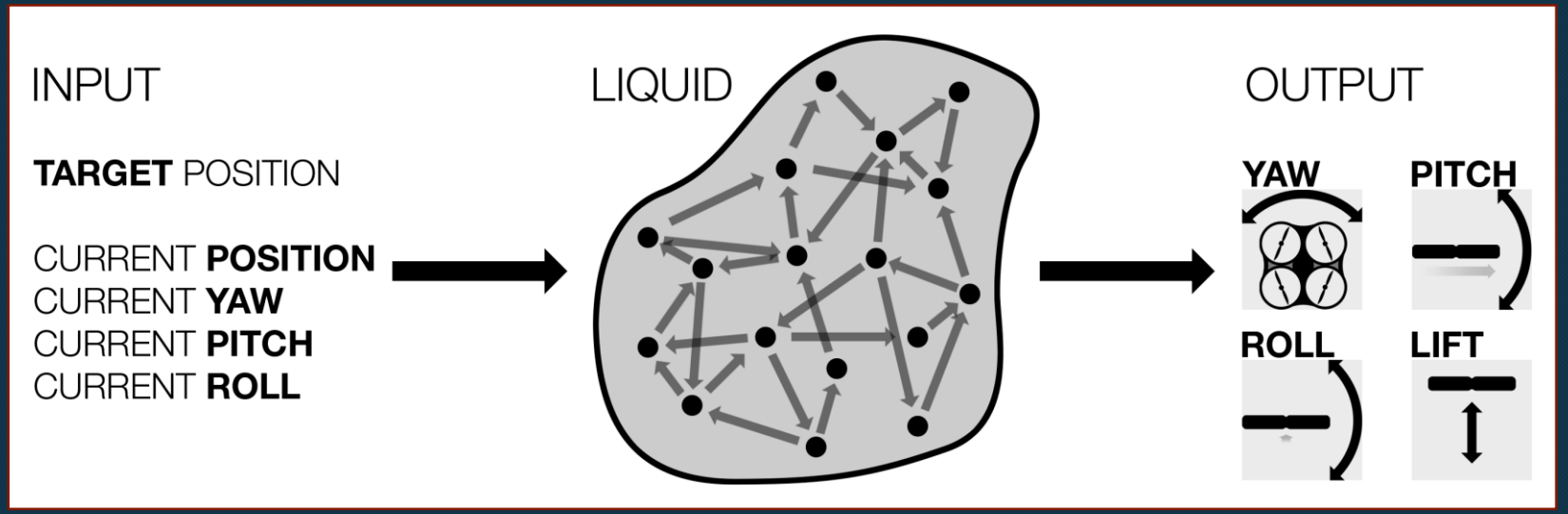

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Neuro-Inspired Hardware

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1000 Nervenzellen (~vergleichbar mit dem Gehirn einer Medusa/Qualle)

Neuro-Inspired Hardware

1000 Nervenzellen (~vergleichbar mit dem Gehirn einer Medusa/Qualle)

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Modelling Complex Human Behaviour for autonmous systems

Prof. Dr. Gordon Pipa, Osnabruck University

Prof. Dr. Peter König, Osnabruck University

Prof. Dr. Achim Stephan, Osnabruck University

The Trolley Dilemma

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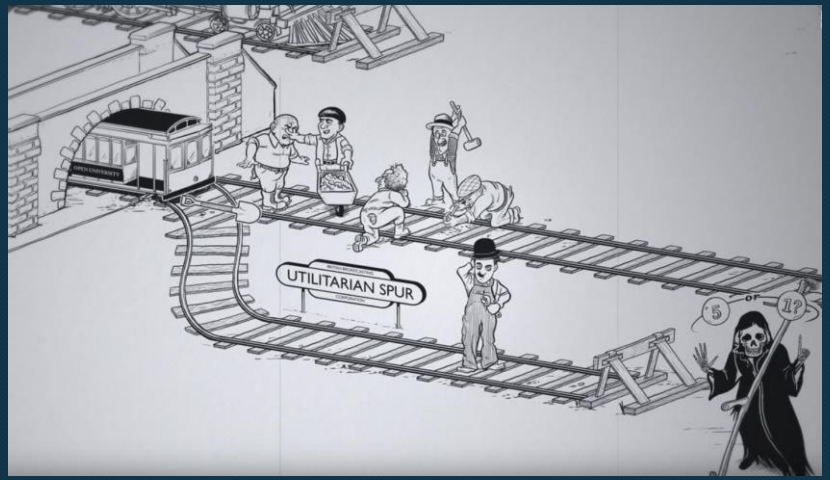
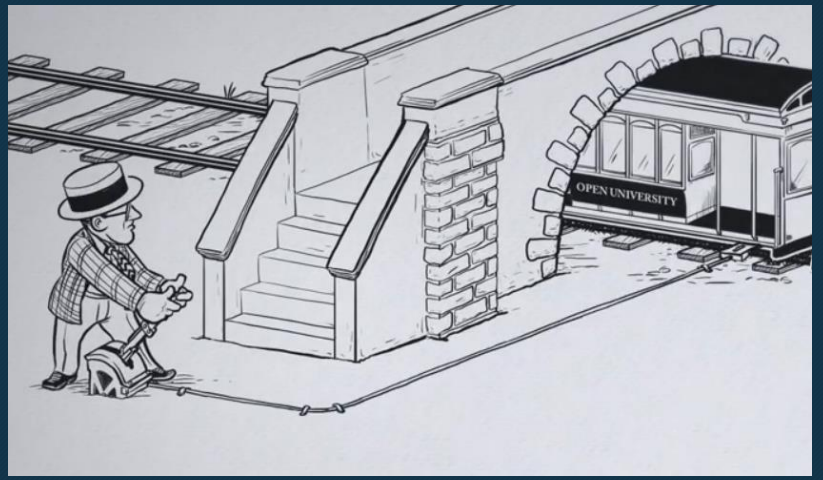
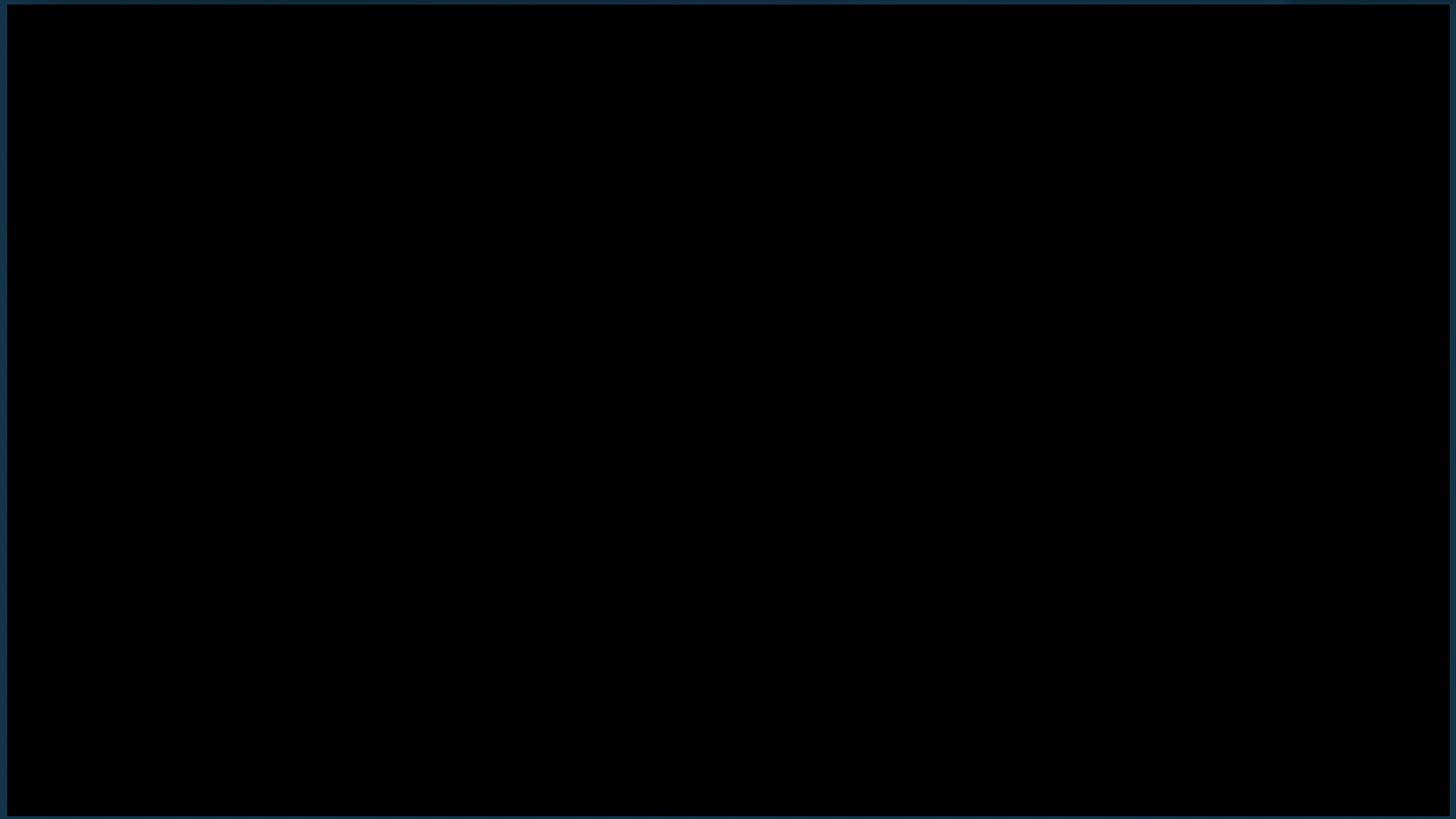


?



https://www.youtube.com/watch?v=bOpf6KcWYyw

https://www.youtube.com/watch?v=BwJ__zAyjSc&t=15s



Modern Ethical Dilemma Research

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THE WALL STREET JOURNAL.

heise online

Daily Mail

The Indian EXPRESS

سیاست
The Siasat Daily

Business Standard

Many more . . .

- L.R. Sütfeld, R. Gast, P. König, G. Pipa, „Using Virtual Reality to Assess Ethical Decisions in Road Traffic Scenarios: Applicability of Value-of-Life-Based Models and Influences of Time Pressure", Front. Behav. Neurosci., 05 July 2017
- Skulmowski A, Bunge A, Kaspar K and Pipa G (2014) Forced-choice decision-making in modified trolley dilemma situations: a virtual reality and eye tracking study. *Front. Behav. Neurosci.* **8**:426. doi: 10.3389/fnbeh.2014.00426

The Moral/Ethical Turing Test

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Modellig Human Moral Behaviour

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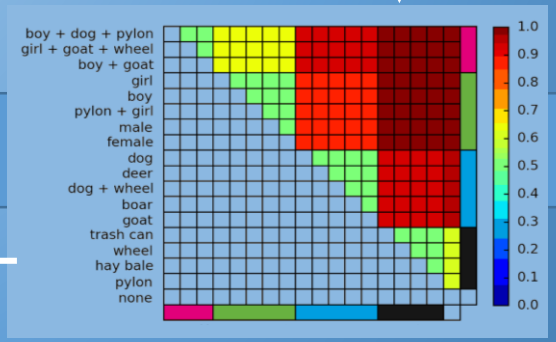
Value-of-life models approximate moral decisions

Human decisions in virtual reality

91.20%
Prediction accuracy

Probabilistic inference



Conceptualized models

Enabling algorithmic behavior of autonomous vehicles

frontiers Blog

L.R. Sütfeld, R. Gast, P. König, G. Pipa, „Using Virtual Reality to Assess Ethical Decisions in Road Traffic Scenarios: Applicability of Value-of-Life-Based Models and Influences of Time Pressure", Front. Behav. Neurosci., 05 July 2017

Probabilistic statistical model (logistic regression)

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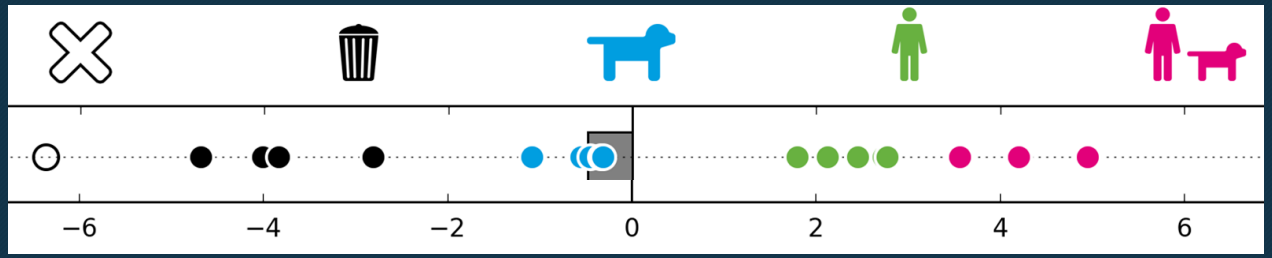
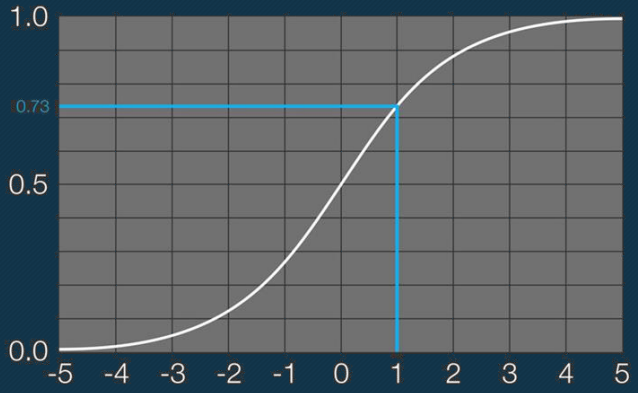


p(left lane) = f(VOL (Dog) – VOL (Girl)) = 0.73



If Model works it should apply for any combination of pairs

Latent Variable Model – Underlying Explainations

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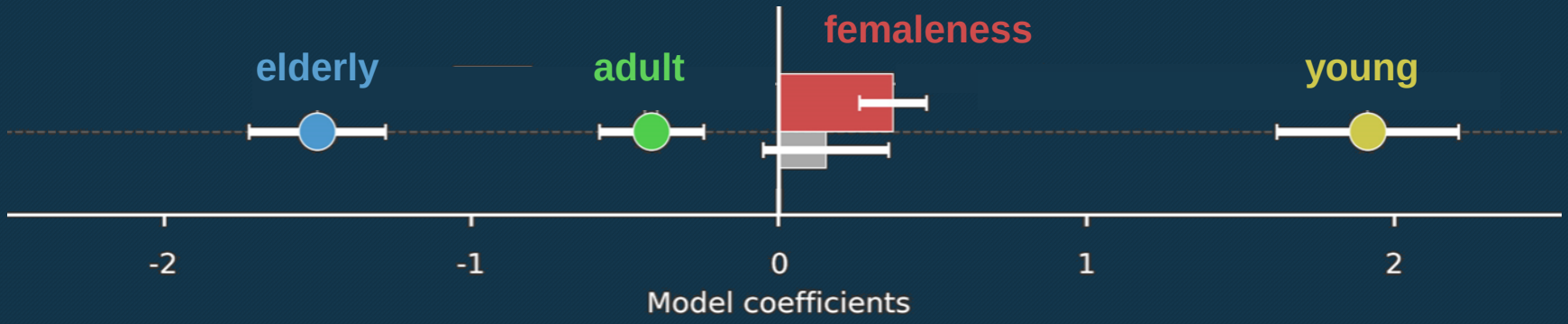

- The data can be explained by 5 latent variables only!
- One variable for age (young/adult/elderly)
- And for femaleness
- One for hands off bias. (Tendency to stay passive)

Thank you to my collaborators on these projects

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Prof. Dr. Pipa
Neuroinformatik

Prof. Dr. Kühnberger
Künstliche Intelligenz

Prof. Dr. König
Neurobiopsychologie

Dr. Thelen
virtUOS & Computer science
Institute of Cognitive Science

Prof. Dr. Stephan
Philosophie des Geistes
und der Kognition

Prof. Dr. Dr. Scheller
Intensive Care, University
Hospital Frankfurt

IBM
Academic Initiative

Try It Yourself **www.flu-prediction.com**

You can download this talk from https://youtu.be/s_TDUjrti4w

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