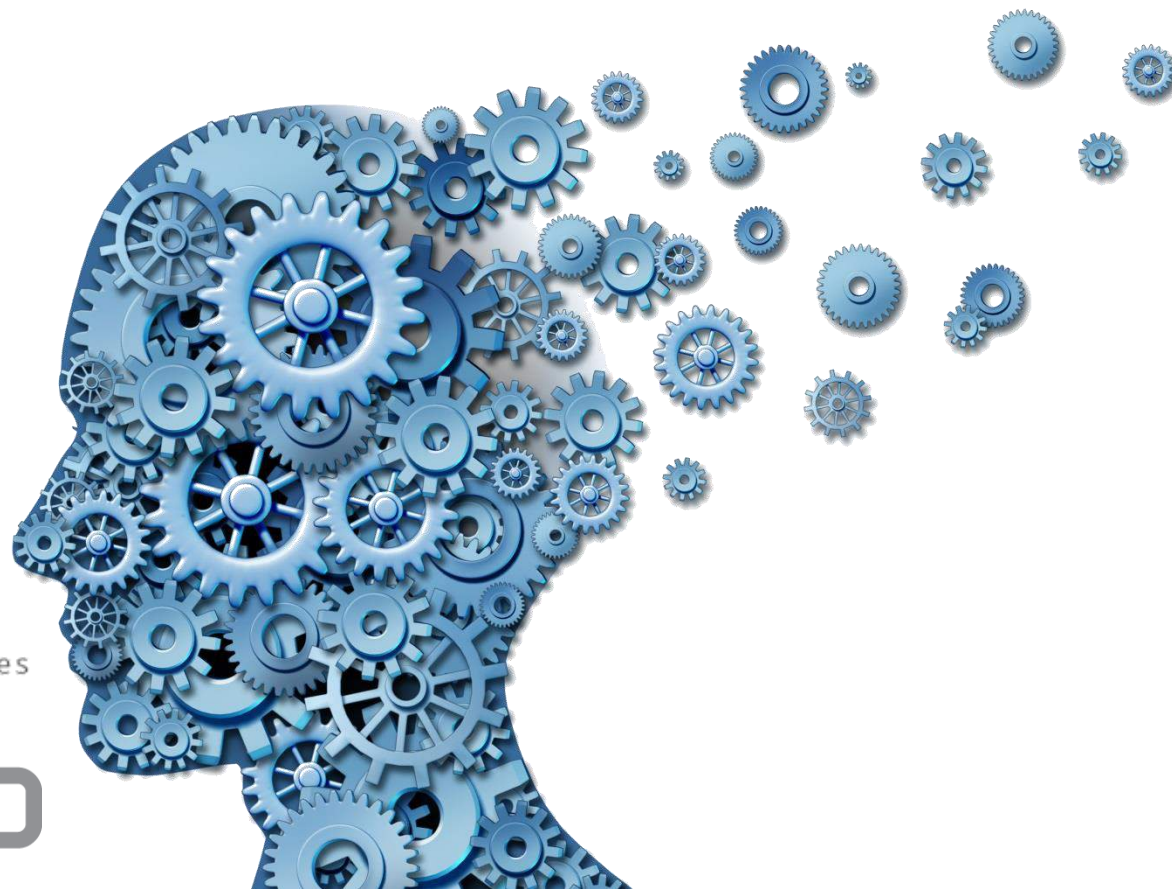


# Der Motor der digitalen Transformation – Eine Winterthurer Perspektive auf Data Science und KI

*WinLink Early Morning Session, 10.05.2017*

Thilo Stadelmann



Swiss Alliance for  
Data-Intensive Services



**data**lab

[www.zhaw.ch/datalab](http://www.zhaw.ch/datalab)

# 1

## Die Entstehung eines Megatrends

# Data Scientist:

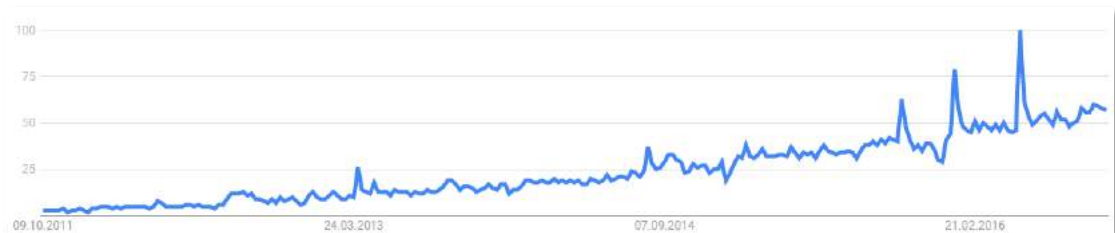
## *The Sexiest Job of the 21st Century*

**Meet the people who can coax treasure out of messy, unstructured data.**

by Thomas H. Davenport  
and D.J. Patil

**W**hen Jonathan Goldman arrived for work in June 2006 at LinkedIn, the business networking site, the place still felt like a start-up. The company had just under 8 million accounts, and the number was growing quickly as existing members invited their friends and colleagues to join. But users weren't seeking out connections with the people who were already on the site at the rate executives had expected. Something was apparently missing in the social experience. As one LinkedIn manager put it, "It was like arriving at a conference reception and realizing you don't know anyone. So you just stand in the corner sipping your drink—and you probably leave early."

70 Harvard Business Review October 2012



# Viele Begriffe, ein Trend: Digitalisierung

## Buzz Words und technologische Treiber

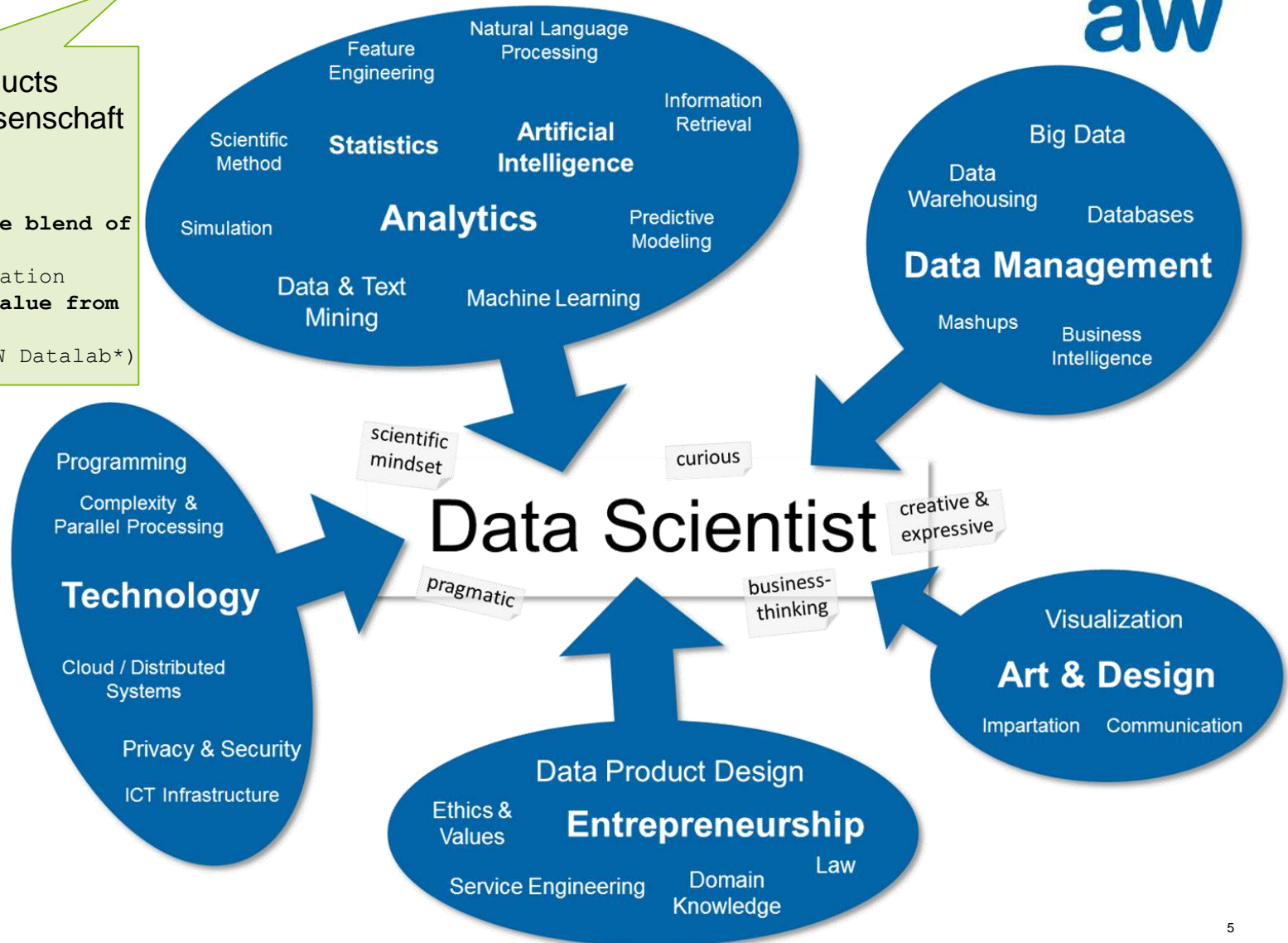




# Was ist Data Science?

Ermöglicht Data Products  
→ **Angewandte** Wissenschaft  
→ Interdisziplinär

Data Science := "Unique blend of **skills** from analytics, engineering & communication aiming at generating **value** from the data itself [...]"  
(ZHAW Datalab\*)



# Die Geschichte eines Sommers

...ermöglicht durch Deep Learning / künstliche Intelligenz

Der **Sommer 2016** lieferte eine beeindruckende Liste **bedeutsamer Durchbrüche** im in der Automatisierung **wahrnehmungsbezogener Aufgaben** in kurzer Zeit.

→ siehe die nächsten 4 Folien





# Google Acquires Artificial Intelligence Startup DeepMind For More Than \$500M

Zürcher Hochschule für Angewandte Wissenschaften



Posted Jan 26, 2014 by Catherine Shu (@catherineshu)



Google will buy reports that th in talks to buy couldn't disclose deal terms.

The acquisition was originally confirmed by Google to Re/code.



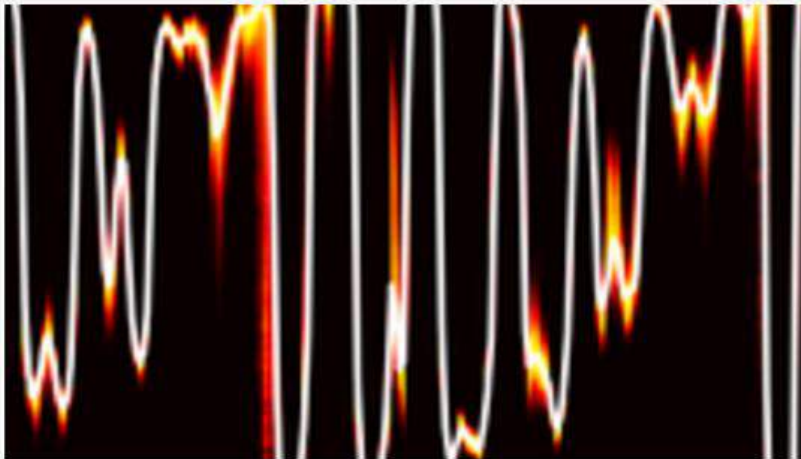
# WaveNet lässt Computersprache natürlich klingen

von Henning Steier / 12.9.2016, 10:05 Uhr

Die Google-Tochter DeepMind hat ein neuronales Netz präsentiert, das Rechner fast wie Menschen klingen lässt. Es macht auch Musik.



KOMMENTARE



DeepMind lässt WaveNet Sprachwellen erzeugen. (Symbolbild: PD)

Die Google-Tochter DeepMind machte zuletzt mit ihrem [Sieg beim Spiel «Go» Schlagzeilen](#): Ihre Software AlphaGo schlug im Frühjahr einen der besten menschlichen Spieler, Lee Sedol. Nun hat das Londoner Unternehmen WaveNet präsentiert: Dieses neuronale Netz erzeugt Sprache, die sehr natürlich klingt – zumindest wenn man die im [Blogeintrag](#) des Unternehmens zu hörenden Klangbeispiele als Massstab nimmt. Man hat sogar das Gefühl, Atempausen zu hören.

## MEISTGELESEN

Künstliche Intelligenz

### Kein Google für jeden

**KOMMENTAR** / Henning Steier / 5.10.2016

Neue Produkte aus Mountain View

### Google macht sich nicht nur im Wohnzimmer breit

Henning Steier / 4.10.2016

Dropbox

### 68 Millionen verschlüsselte Passwörter im Netz

5.10.2016



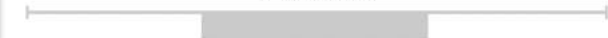
Generierte Sprache  
«aus Texteingabe»



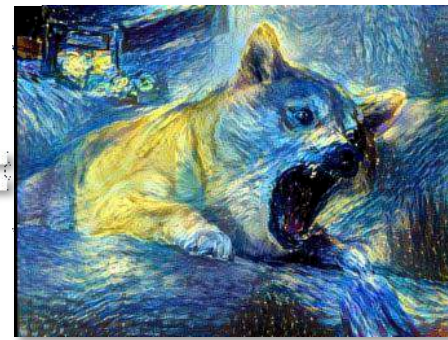
Generierte Musik  
«ohne Inhaltsvorgabe»



1 Second







Computing

# Algorithm Clones Van Gogh's Artistic Style and Pastes It onto Other Images, Movies

A deep neural network has learned to transfer artistic styles to other images.

by Emerging Technology from the arXiv May 10, 2016



+



=



The nature of artistic style is something of a mystery to most people. Think

of Vincent Van Gogh's *Starry, Starry Night*, or Edvard Munch's *The Scream*. These are the kinds of images that humans recognize easily.



+



=





# ...und die Liste liesse sich fortsetzen!

Brandon Amos About Blog

## Image Completion with Deep Learning in TensorFlow

August 9, 2016



- Introduction
- Step 1: Interpreting images as samples from a probability distribution
  - How would you fill in the missing information?
  - But where does statistics fit in? These are images.
  - So how can we complete images?
- Step 2: Quickly generating fake images
  - Learning to generate new samples from an unknown probability distribution
  - [ML-Heavy] Generative Adversarial Net (GAN) building blocks
  - Using  $C(z)$  to produce fake images
  - [ML-Heavy] Training DCGANs
  - Existing GANs
  - [ML-Heavy] Training DCGANs
  - Running DCGANs
- Step 3: Finding the right image
  - Image completion
  - [ML-Heavy] Training DCGANs
  - [ML-Heavy] Training DCGANs
  - Completing images
- Conclusion
- Partial bibliography
- Bonus: Incomplete images

### Introduction

Content-aware fill is a popular technique for image completion and inpainting. In this post, we'll show how to use deep learning to do content-aware fill, inspired by the work of Criminisi et al. (2004). "Semantic Image Inpainting Shows How to Use Deep Learning to Do Content-Aware Fill in a Matter of Minutes." [http://arxiv.org/abs/1503.04219](#)

We'll approach image completion in three steps:

1. We'll first interpret the image as a probability distribution.
2. This interpretation allows us to generate new samples from an unknown probability distribution.
3. Then we'll find the right image to complete the image.



Andrej Karpathy blog About Hacker's guide to Neural Networks

## The Unreasonable Effectiveness of Recurrent Neural Networks

May 21, 2015

There's something magical about Recurrent Neural Networks (RNNs). I still remember when I trained my first recurrent network for image captioning. Within a few dozen minutes of training my first baby model (with rather arbitrarily-chosen hyperparameters), started to generate very nice looking descriptions of images that were on the edge of making sense. Sometimes the ratio of how simple your model is to the quality of the results you get out of it blows past your expectations, and this was one of those times. What made this result so shocking at the time was that the common wisdom was that RNNs were supposed to be difficult to train (with more experience I've in fact reached the opposite conclusion). Fast forward about a year: I'm training RNNs all the time and I've witnessed their power and robustness many times, and yet their magical outputs still find ways of amusing me. This post is about sharing some of that magic with you.

*"We'll train RNNs to generate text character by character and ponder the question 'how is that even possible?'"*

By the way, together with this post I am also releasing code on GitHub that allows you to train character-level language models based on multi-layer LSTMs. You give it a large chunk of text and it will learn to generate text like it one character at a time. You can also use it to reproduce my experiments below. But we're getting ahead of ourselves. What are RNNs anyway?

### Recurrent Neural Networks

**Sequences.** Depending on your background you might be wondering: *What makes Recurrent Networks so special?* A glaring limitation of Vanilla Neural Networks (and also Convolutional Networks) is that their API is too constrained: they accept a fixed-sized vector as input (e.g. an image) and produce a fixed-sized vector as output (e.g. probabilities of different classes). Not only that: These models perform this mapping using a fixed amount of computational steps (e.g. the number of layers in the model). The core reason that recurrent nets are more exciting is that they allow us to operate over sequences of vectors: in the input, the output, or in the most general case both. A few examples may make this more concrete:

#### VIOLA:

Why, Salisbury must find his flesh and thought  
That which I am not apes, not a man and in fire,  
To show the reining of the raven and the wars  
To grace my hand reproach within, and not a fair are hand,  
That Caesar and my goodly father's world;  
When I was heaven of presence and our fleets,  
We spare with hours, but cut thy council I am great,  
Murdered and by thy master's ready there  
My power to give thee but so much as hell:  
Some service in the noble bondman here,  
Would show him to her wine.

#### KING LEAR:

O, if you were a feeble sight, the courtesy of your law,  
Your sight and several breath, will wear the gods  
With his heads, and my hands are wonder'd at the deeds,  
So drop upon your lordship's head, and your opinion  
Shall be against your honour.

On the right, a recurrent network generated images of digits by learning to sequentially add color to a canvas (Gregor et al.):



## the morning paper

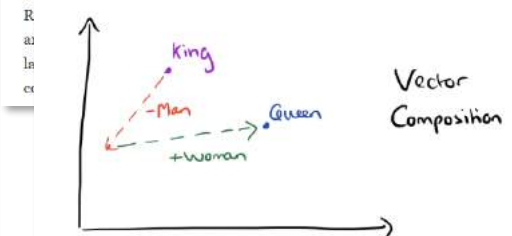
### The amazing power of word vectors

APRIL 21, 2016

For today's post, I've drawn material not just from one paper, but from five! The subject matter is 'word2vec' – the work of Mikolov et al. at Google on efficient vector representations of words (and what you can do with them). The papers are:

- **Efficient Estimation of Word Representations in Vector Space** – Mikolov et al. 2013
- **Distributed Representations of Words and Phrases and their Compositionality** – Mikolov et al. 2013
- **Linguistic Regularities in Continuous Space Word Representations** – Mikolov et al. 2013
- **word2vec Parameter Learning Explained** – Rong 2014
- **word2vec Explained: Deriving Mikolov et al's Negative Sampling Word-Embedding Method** – Goldberg and Levy 2014

From the first of these papers ('Efficient estimation...') we get a description of the *Continuous Bag-of-Words* and *Continuous Skip-gram* models for learning word vectors (we'll talk about what a word vector is in a moment...). From the second paper we get more illustrations of the power of word vectors, some additional information on optimisations for the skip-gram model (hierarchical softmax and negative sampling), and a discussion of *analogical word vectors* in phrases. The titled paper ('Linguistic...')



# Die Geschichte von Rocket AI @ NIPS'2016

## Oder: Die Gefahr hinter Hype

# ROCKET AI

NEXT GENERATION OF APPLIED AI

Zitat aus dem Blogbeitrag (<https://medium.com/the-mission/rocket-ai-2016s-most-notorious-ai-launch-and-the-problem-with-ai-hype-d7908013f8c9#9gigyxe5>):

**Turns out anyone can make a multi-million dollar company in 30 minutes** ...with a website editor whilst in a Spanish mansion found on Airbnb. *'Temporally Recurrent Optimal Learning'* is a combination of buzzwords we put together to spell out TROL(L) that were conjured up over breakfast. **If we hadn't put significant effort into making sure people realized it was a joke, Rocket AI would be in the press right now.**

Metrics for the Rocket AI launch party:

Email RSVPs to party: 316  
People who emailed in their resume: 46  
Large name brand funds who contacted us about investing: 5  
Media: Twitter, Facebook, HackerNews, Reddit, Quora, Medium etc  
Time Planning: < 8 hours  
Money Spent: \$79 on the domain, \$417 on alcohol and snacks + (police fine)  
For reference, NIPS sponsorship starts at \$10k.  
  
Estimated value of Rocket AI: *in the tens of millions.*



# 2

**...und was wir damit machen**



# ZHAW Datalab: Est. 2013

## Forerunner

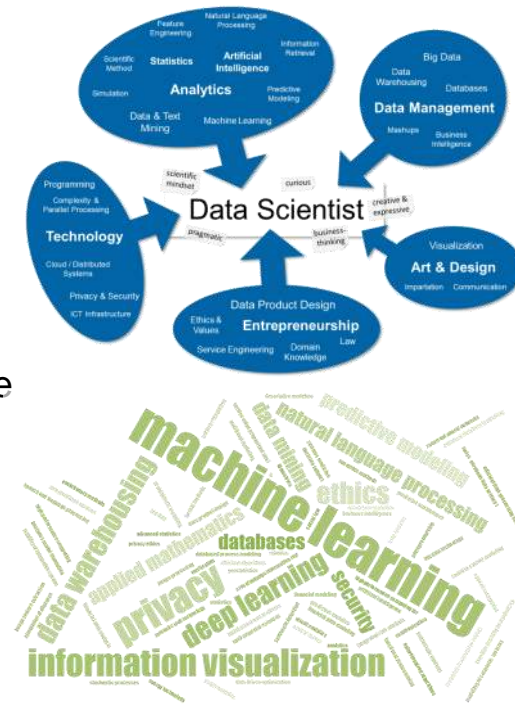
- **One of the first** interdisciplinary data science initiatives in Europe
- One of the first interdisciplinary centers at ZHAW

## Foundation

- **People:** ca. 70 researchers from 5 institutes / 3 departments opted in
- **Vision:** Nationally leading and internationally recognized center of excellence
- **Mission:** Generate projects through critical mass and mutual relationships
- **Competency:** Data product design with structured and unstructured data

## Success factors

- **Lean** organization and operation → geared towards projects
- Years of successful **pre-Datalab collaboration**



# R&D

## Volume

- > 9 Mio. CHF 3<sup>rd</sup> party funding in first 4 years
- **Overall turnover** of projects up to spring 2017: > **19.5 Mio. CHF** in < **4 years**

## Topics: all of digitization

- Industry 4.0 (e.g., CTI project «DaCoMo»)
- E-Health (e.g. CTI application «SenSkin»)
- FinTech (e.g., CTI project «DatFisMo»)
- Mobility (e.g., project «Placebook»)
- Sustainability (e.g., CTI project «EAT-IT CO<sub>2</sub>»)
- Technology (e.g., CTI project «Zurich NoSQL»)
- ...

## Spin-offs

-  Prognosix – a ZHAW IAS spin-off
-  SPINNINGBYTES – a joint spin-off from ZHAW and ETH

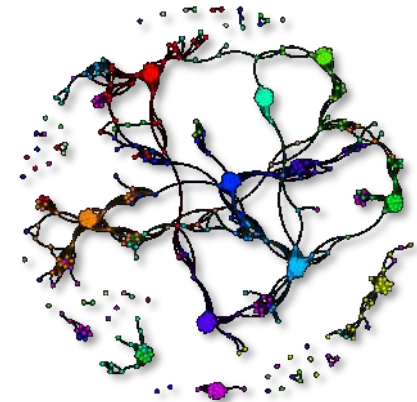


Figure: Visualizing the relationships of all Swiss foundations, based on the similarity of goals as expressed in their statutes. A proud collaboration of InIT and IDP within CTI project «Stiftungsregister SR 2.0»



# Education

## Undergraduate

- Involved in numerous courses of B.Sc. Programs  
→ e.g., «scripting», «big data», «data mining», «AI», «information retrieval», «data warehousing», ...

## Graduate and post-graduate

- **Master of Science in Engineering** modules: e.g., «machine learning»
- **Ph.D. programs:** with Universities of Venice, Zurich, and Neuchatel
- Other planned collaborations: ambitions for **M.Sc. program**

MSE



swissuniversities

## Professional education

- Master of Advanced Studies (**MAS**) in **Data Science**
- **Only technical** oriented data science program in Switzerland!
- **Completely booked** almost until end of 2019



# Education: MAS in Data Science

Master of Advanced Studies (MAS) professional education program

- Since fall 2014; completely booked till fall 2018 (as of fall 2016)
- Pick 3 out of 5 modules (part time, one day per week)

## CAS Machine Intelligence

Machine Learning,  
Deep Learning,  
Text Analysis, Advanced topics  
in Big Data

## CAS Statistical Modeling

Information processing with R,  
Advanced regression modeling,  
Analysis of time to event data,  
Network analysis

## CAS Data Product Design

Data-specific Service Design,  
Data-specific Business Models,  
Practice workshop,  
Security & Privacy

## CAS Information Engineering

Scripting in Python,  
Information Retrieval &  
Text Analytics, Databases &  
SQL, Data Warehousing,  
Big Data

## CAS Data Analytics

Data Description &  
Visualization, Statistical  
Foundations of Analytics,  
Multiple Regression,  
Time Series & Forecasting,  
Clustering & Classification

→ Strong demand from industry; easily convertible to summer/winter school formats

# Community outreach



## SDS – Swiss Conference series on Data Science

- SDS|2014: ca. 120 participants (planned 60)
- SDS|2015: ca. 190 participants
- SDS|2016: full house @ 230 participants, several international keynote speakers invited
- SDS|2017: will move to bigger conference venue in Bern, internationally recognized

## Generating impact

- Workshop organization: e.g. SwissText 2016 (Swiss conference on text understanding)
- Keynotes: e.g. IBM Business Connect 2013, SwissICT 2014, SAS Forum 2016
- Overview publications: e.g. **book on applied data science** (to appear with Springer)
- Leader of **National Thematic Network**: Swiss Alliance for Data-Intensive Services







## Swiss Alliance for Data-Intensive Services

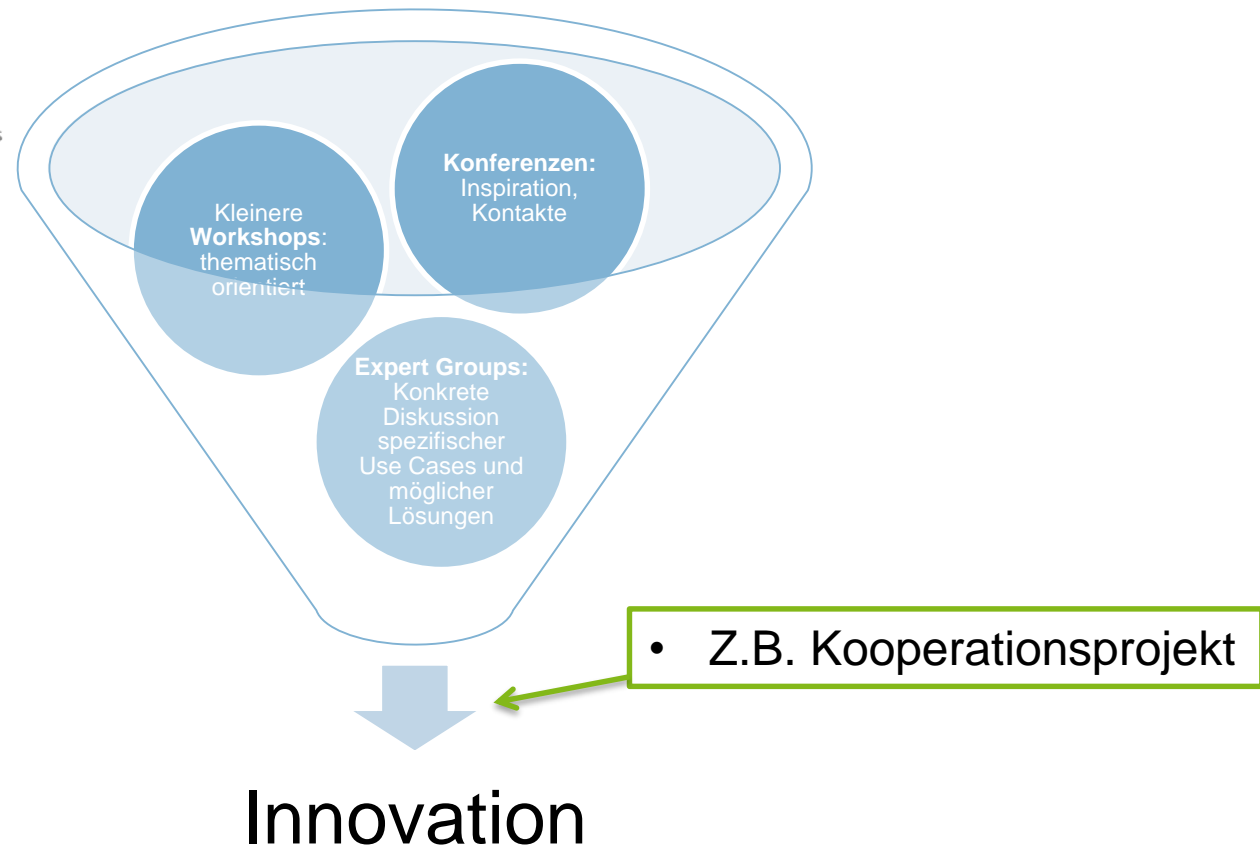
- A **Swiss-wide network of competence** for innovative companies and universities
- **Goal:** Creating data-driven product & service **innovation** through collaboration and education
- **Competencies:** technology & analytics (**data science**); business & human factors (**service science**)
- **Focus:** (a) industrial services; (b) digital and mobile services for humans



# Der Innovationstrichter



Swiss Alliance for  
Data-Intensive Services



## Overview

### Partners

Who are we

- ARGUS der Presse AG**
- Switzerland's leading media monitoring and information provider
  - Experience of more than 100 years

- ZHAW Datalab**
- Interdisciplinary research group at Zurich University of Applied Sciences
  - Combining the knowledge of different fields related to machine learning

### The Project

What do we do

- Goal**
- Real Time Print Media Monitoring
  - Extraction of relevant articles from newspaper pages
  - Delivering articles to customers
- Problem**
- Fully automated article segmentation
  - Identification of article elements (e.g. title, subtitle, etc.)



#### Grosse Ambitionen, kleines Budget



#### Ein Macho auf Eggetrip



### Rule based

Segmentation based on hardcoded rules

- Rule examples**
- Each article must contain a title
  - Titles define article's width
  - Articles are graphically separated by e.g. lines
  - etc.
- Pros**
- Performance increases the more time is spent for finding rules
  - Adding new rules is simple
- Cons**
- Not every case can be covered
  - Adaptation to new layouts is costly manual work



### Image based

Segmentation based on visual features and deep learning

- Approach**
- Pixel classification (article/border, based on [1])
- Pros**
- Rules can be learned implicitly
  - New layouts can be adapted automatically
- Cons**
- Success factors on new data and problems are unknown
  - Training requires a huge amount of data



## Approach

### Text based

Segmentation based on textual features and neural nets

- Approach**
- Text block clustering (semantic distance) based on [2]
- Pros**
- Rules can be learned implicitly
  - Not layout dependent
- Cons**
- Only text can be processed



### Combination

Combination of rules, visual and textual features



Final segmentation



## Result

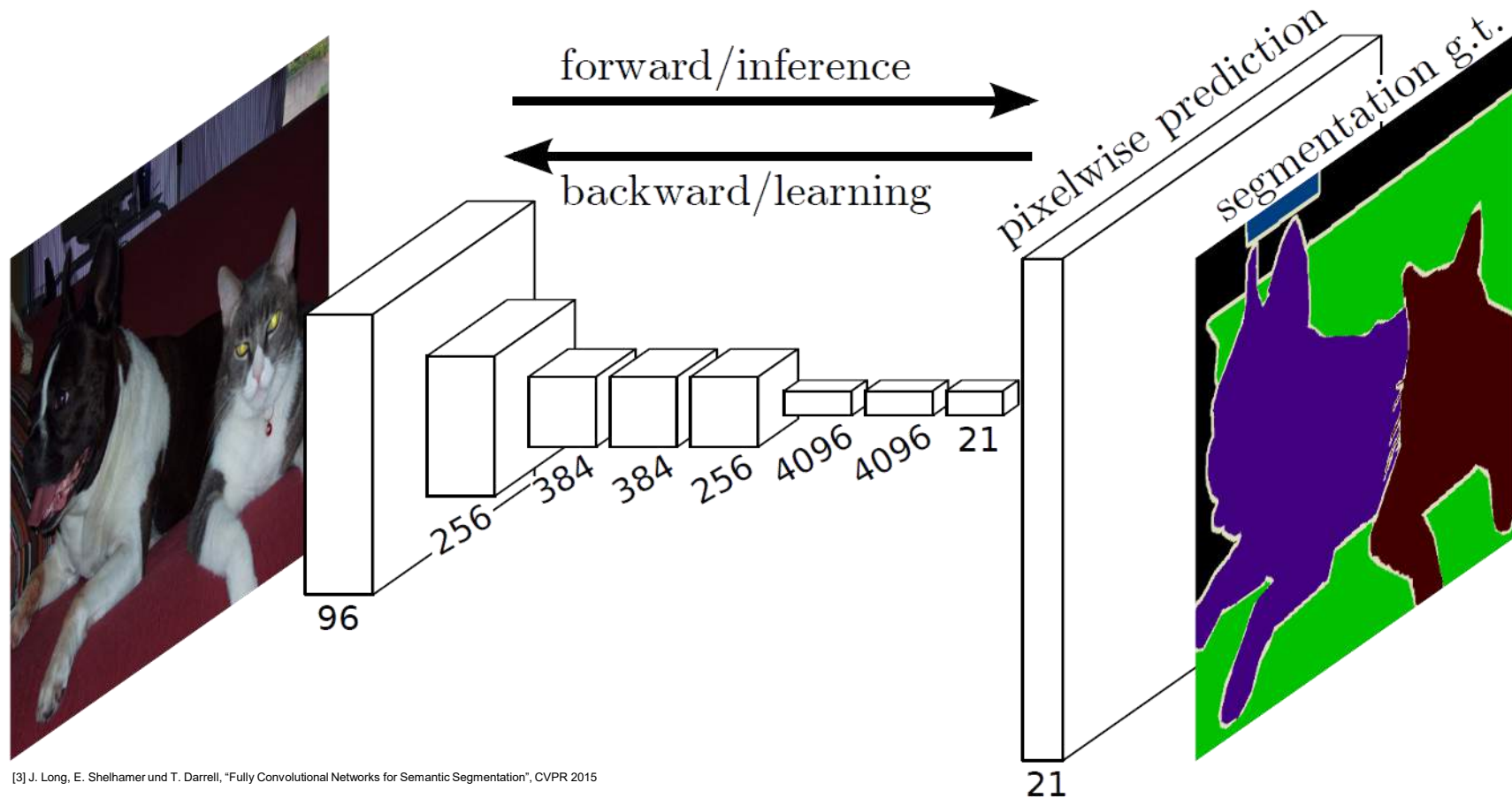
### References

- [1] D. C. Ciresan, A. Giusti, L. M. Gambardella, and J. Schmidhuber. *Deep neural networks segment neuronal membranes in electron microscopy images*. In *NIPS*, pages 2852–2860, 2012.
- [2] T. Mikolov, K. Chen, G. Corrado, and J. Dean. *Efficient Estimation of Word Representations in Vector Space*. In *Proceedings of Workshop at ICLR*, 2013.



# Erweiterung: Semantische Segmentierung

## Projektbeispiel (contd.)



[3] J. Long, E. Shelhamer und T. Darrell, "Fully Convolutional Networks for Semantic Segmentation", CVPR 2015

# Vorläufige Endergebnisse

## Projektbeispiel (contd.)

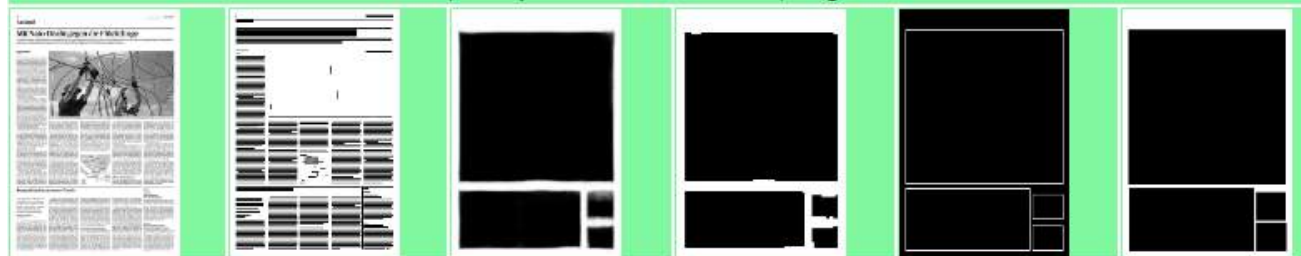
DER-Score=0.22180142908542302, Completeness-Score=0.1, Segmentation-Time=4492ms



DER-Score=0.025586257849471224, Completeness-Score=1.0, Segmentation-Time=4031ms



DER-Score=0.035989922779227114, Completeness-Score=0.25, Segmentation-Time=3914ms



# Data+Service Labs

- Service Design Lab
  - 1-2 days in Schloss Thun
  - Professional coaching
  - Provided by Mobiliar

*Swiss Mobiliar*  
Insurance & Pensions



- Smart Factory Lab
  - Smart factory showcase
  - Featuring Swiss technology
  - Culmination point for research
  - Provided by Georg Fischer Machining Solutions

**+GF+**  
GEORG FISCHER

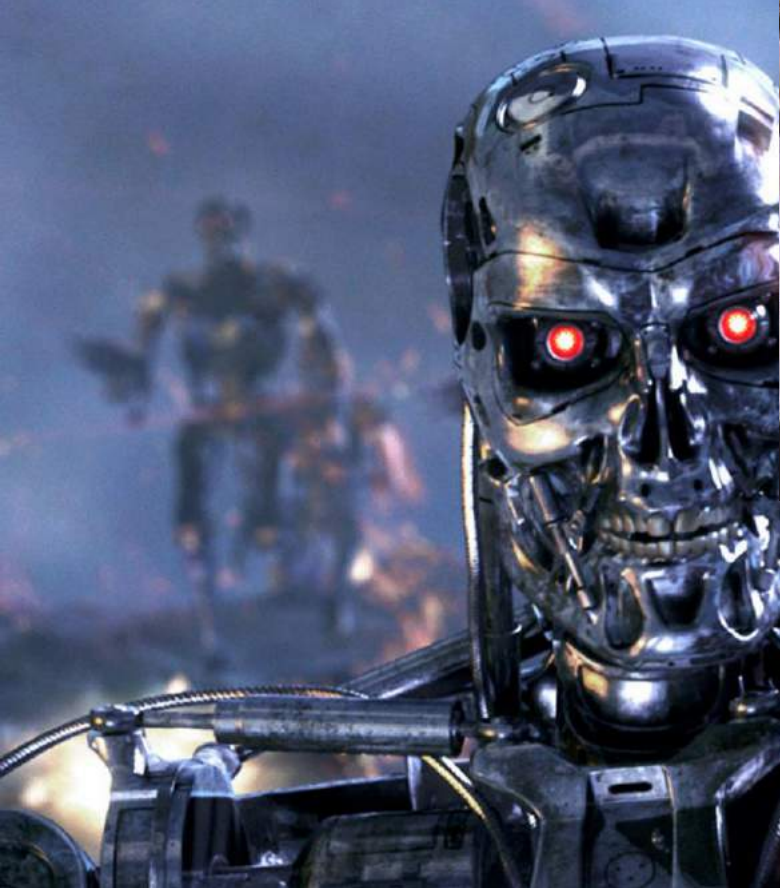
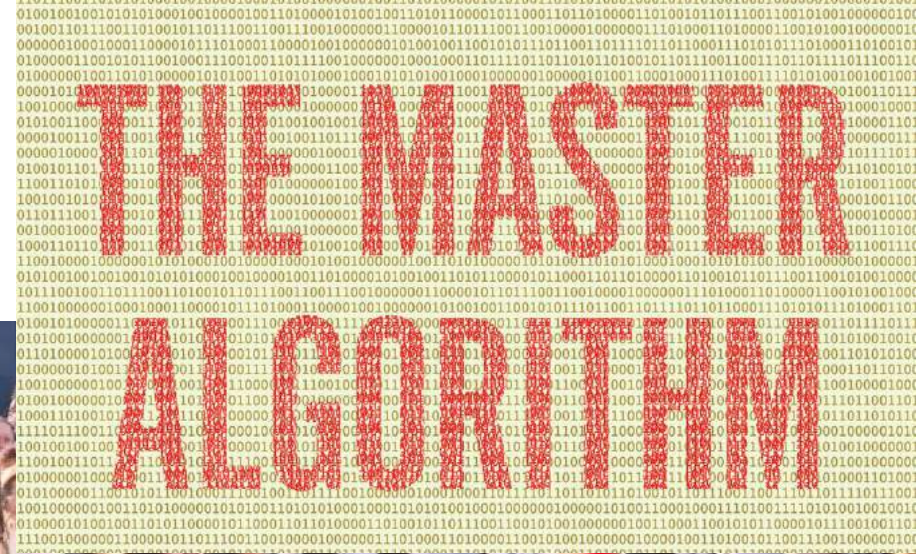


# 3

## Eine Zukunftsprognose



# Was ich nicht erwarte





# Was ich erwarte

## MODERN DATA SCIENTIST

Data Scientist, the sexiest job of the 21st century, requires a mixture of multidisciplinary skills ranging from an intersection of mathematics, statistics, computer science, communication and business. Finding a data scientist is hard. Finding people who understand who a data scientist is, is equally hard. So here is a little cheat sheet on who the modern data scientist really is.

### MATH & STATISTICS

- ☆ Machine learning
- ☆ Statistical modeling
- ☆ Experiment design
- ☆ Bayesian inference
- ☆ Supervised learning: decision trees, random forests, logistic regression
- ☆ Unsupervised learning: clustering, dimensionality reduction
- ☆ Optimization: gradient descent and variants



### PROGRAMMING & DATABASE

- ☆ Computer science fundamentals
- ☆ Scripting language e.g. Python
- ☆ Statistical computing packages, e.g., R
- ☆ Databases: SQL and NoSQL
- ☆ Relational algebra
- ☆ Parallel databases and parallel query processing
- ☆ MapReduce concepts
- ☆ Hadoop and Hive/Pig
- ☆ Custom reducers
- ☆ Experience with xaaS like AWS

### DOMAIN KNOWLEDGE & SOFT SKILLS

- ☆ Passionate about the business
- ☆ Curious about data
- ☆ Influence without authority
- ☆ Hacker mindset
- ☆ Problem solver
- ☆ Strategic, proactive, creative, innovative and collaborative

### COMMUNICATION & VISUALIZATION

- ☆ Able to engage with senior management
- ☆ Story telling skills
- ☆ Translate data-driven insights into decisions and actions
- ☆ Visual art design
- ☆ R packages like ggplot or lattice
- ☆ Knowledge of any of visualization tools e.g. Flare, D3.js, Tableau

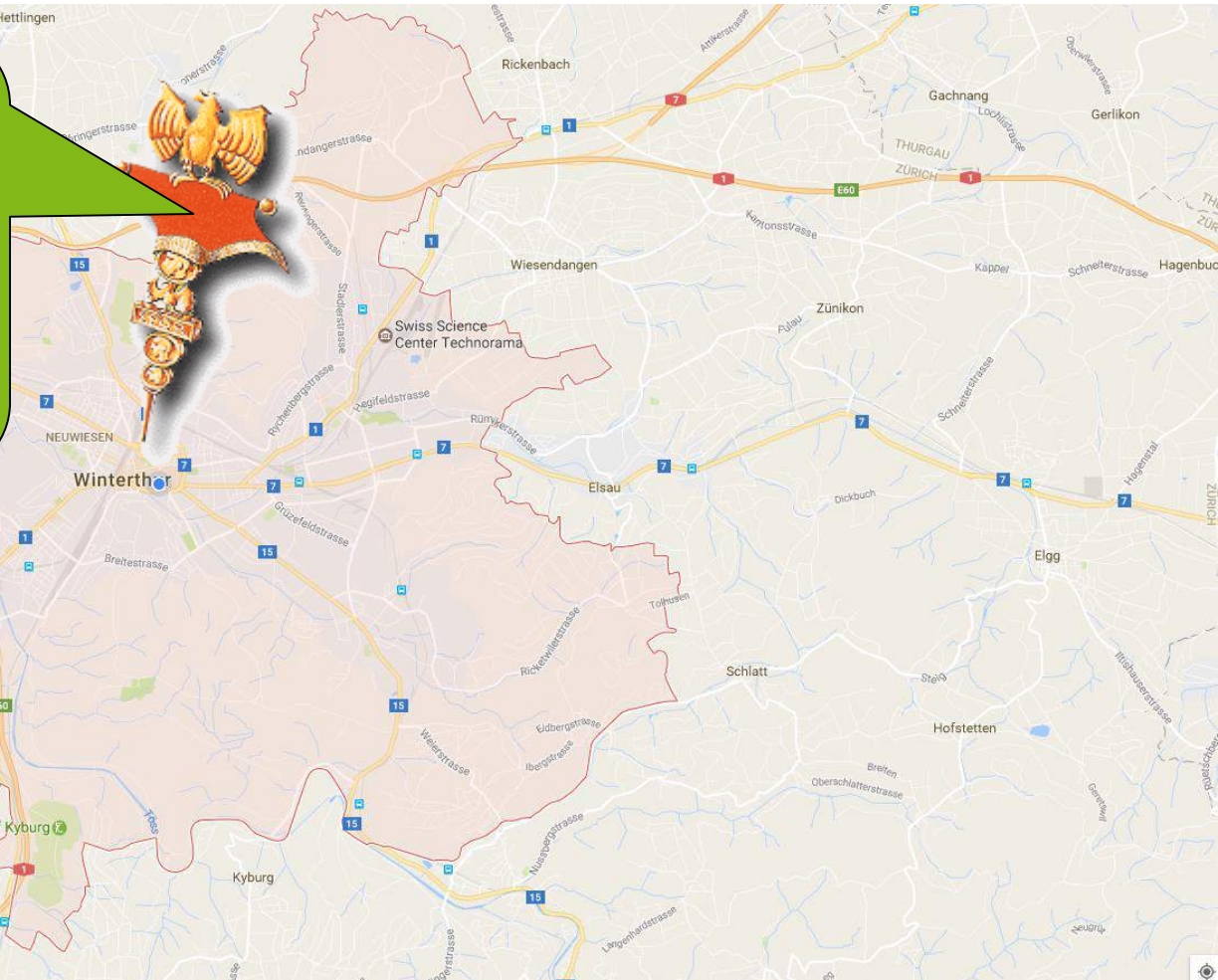


# Was ich mir vorstellen kann

## Eine Vision sucht Mitvisionäre

### Winterthur: Hub für Digitalisierung

- ZHAW Datalab
- Data+Service
- Technopark
- WinLink
- Standortförderung
- Lokale Industrie
- ...





# Schlussfolgerungen

- **Digitalisierung** (unter anderem Namen) wird uns die nächsten **+10 Jahre** begleiten
- Die dazugehörigen **Veränderungen** sind **disruptiv, gestaltbar, aussichtsreich**
- **Winterthur** hat eine **grosse Chance**, Gestalter im grossen Stil zu sein



## Mehr zu mir:

- Leiter ZHAW Datalab, Boardmitglied Data+Service
- [thilo.stadelmann@zhaw.ch](mailto:thilo.stadelmann@zhaw.ch)
- 058 934 72 08
- [www.zhaw.ch/~stdm](http://www.zhaw.ch/~stdm)



## Mehr zum Thema:

- Verband Data & Service Science: [www.data-service-alliance.ch](http://www.data-service-alliance.ch)
- Gemeinsame Projekte: [datalab@zhaw.ch](mailto:datalab@zhaw.ch)

→ Fragen Sie gerne an.