

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



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Die Entstehung eines Megatrends

Data Scientist: *The Sexiest Job of the 21st Century*

Zürcher Hochschule
für Angewandte Wissenschaften

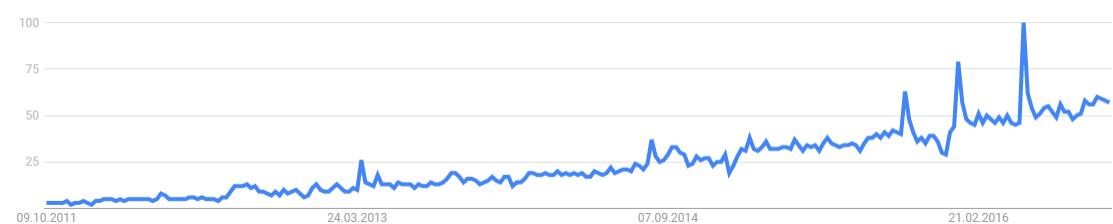


**Meet the people who
can coax treasure out of
messy, unstructured data.**

by Thomas H. Davenport
and D.J. Patil

When 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

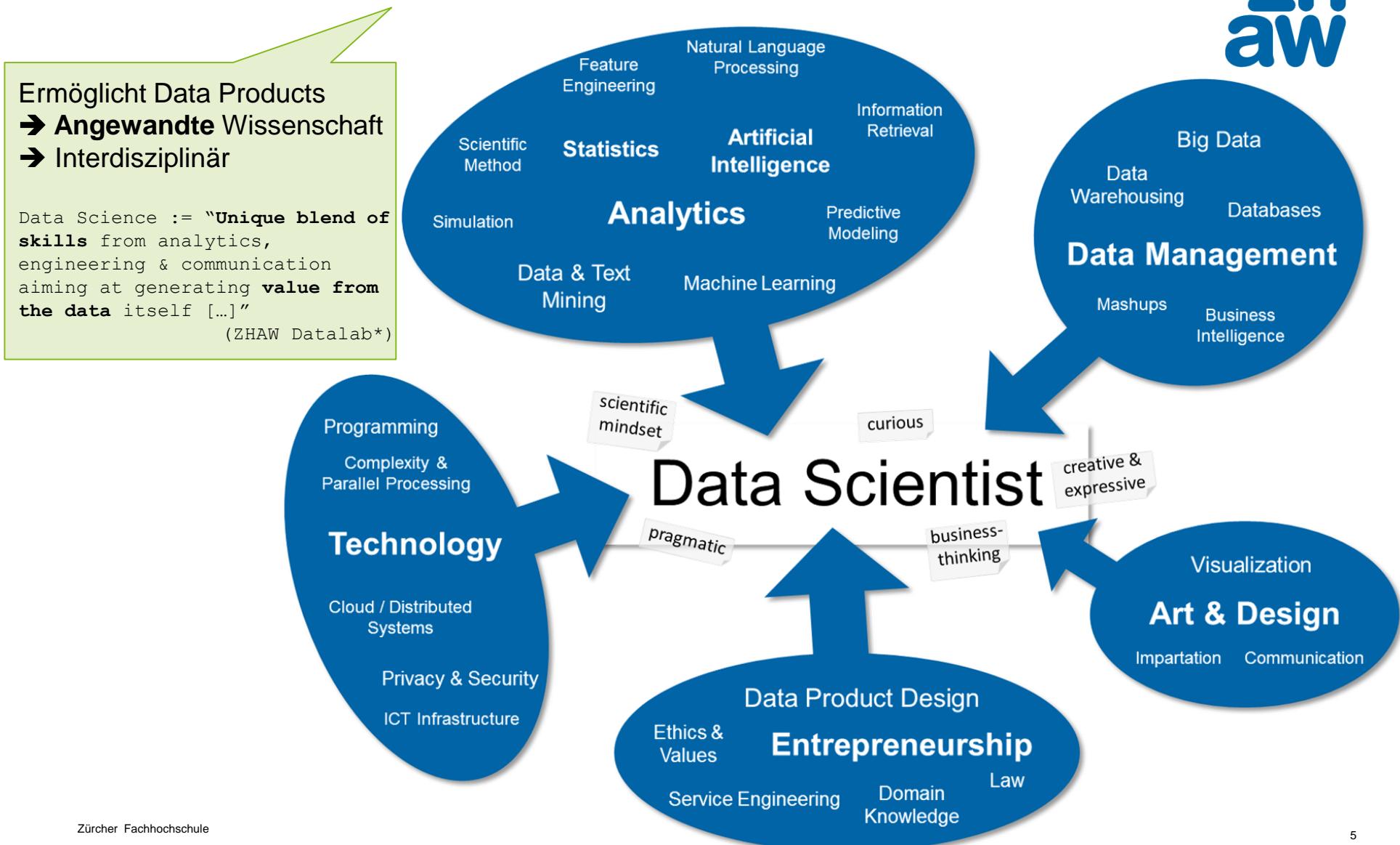


Viele Begriffe, ein Trend: Digitalisierung

Buzz Words und technologische Treiber



Was ist Data Science?



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

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



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

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



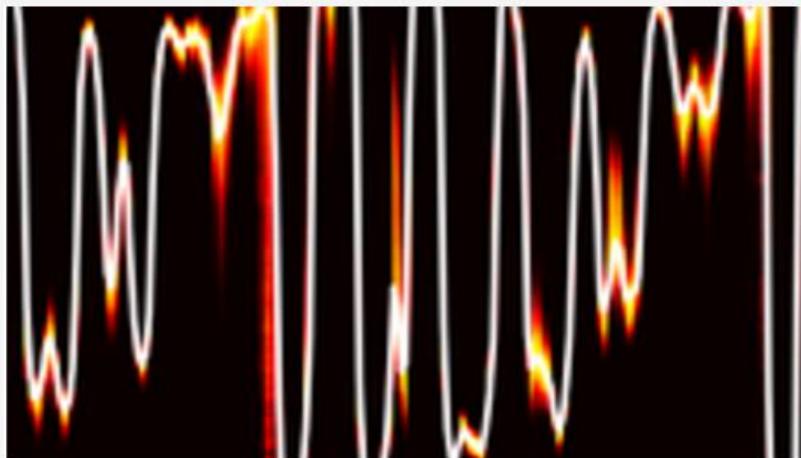
WaveNet lässt Computersprache natürlich klingen

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

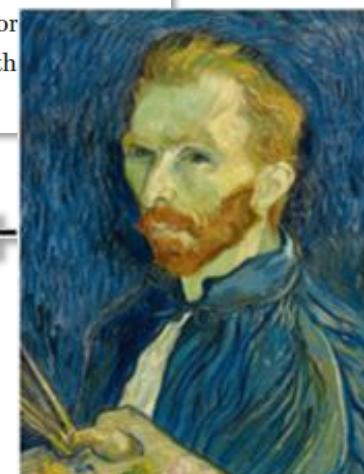
A deep neural network has learned to transfer artistic styles to other images.

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 Night*, or Edvard Munch's *The Scream*, or any other image that humans recognize easily.



...und die Liste liesse sich fortsetzen!

Brandon Amos [About](#) [Blog](#)

[Image Completion with Deep Learning in TensorFlow](#)
August 9, 2016

[Twitter](#) [Facebook](#) [Google+](#) [LinkedIn](#) [StumbleUpon](#) [Email](#)

- [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 $G(z)$ to produce fake images
 - [ML-Heavy] Training DCGANs
 - Existing GANs
 - [ML-Heavy] DCGANs
 - Running DCGANs
- [Step 3: Finding the right completion](#)
 - Image completion
 - [ML-Heavy] 1
 - [ML-Heavy] 2
 - Completing your images
- [Conclusion](#)
- [Partial bibliography](#)
- [Bonus: Incomplete](#)

Introduction

Content-aware fill is a powerful technique for image completion and inpainting. It can do content-aware fill, image completion, and semantic image inpainting. The "Semantic Image Inpainting" section shows how to use deep learning to fill in some deeper portions of images. If you're interested in learning more about this section, you can skip forward to the "Image Completion with Deep Learning in TensorFlow" section. I have also written a blog post on "Content-aware image completion with TensorFlow".

1. [We'll first interpret the image](#)
2. [This interpretation will help us find the right completion](#)
3. [Then we'll find the right completion](#)

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: Sequences in the input, the output, or in the most general case both. A few examples may make this more concrete:

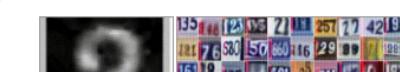
VIOLA:

Why, Salisbury must find his flesh and thought
That which I am not aps, 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.

the right, a recurrent network generates 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

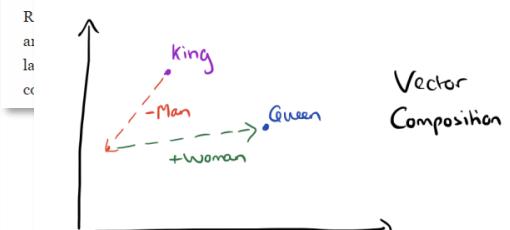
★ [Distributed Representations of Words and Phrases and their Compositionality](#) – Mikolov et al. 2013

★ [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 *analogies* and *metaphors* to illustrate the third paper's findings.



Die Geschichte von Rocket AI @ NIPS'2016

Oder: Die Gefahr hinter Hype



Zitat aus dem Blogbeitrag (<https://medium.com/the-mission/rocket-ai-2016s-most-notorious-ai-launch-and-the-problem-with-ai-hype-d7908013f8c9#.9gjgyxre5>):

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.*

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...und was wir damit machen

ZHAW Datalab: Est. 2013



Forerunner

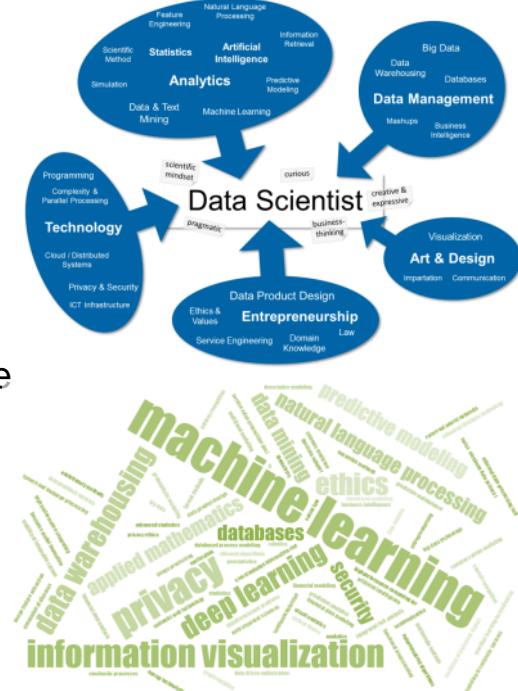
- **One of the first** interdisciplinary data science initiatives in Europe
- One of the first interdisciplinary centers at ZHAW

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

Spin-offs

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

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 CO₂»)
- Technology (e.g., CTI project «Zurich NoSQL»)
- ...

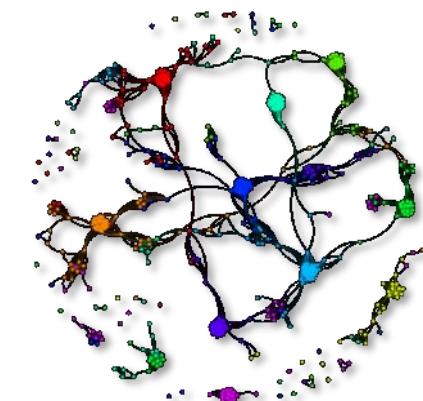


Figure: Visualizing the relationships of all Swiss foundations, based on the similarity of goals as expressed in their statutes. A proud collaboration of Init and IDP within CTI project «Stiftungsregister SR 2.0»

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**



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

Industrial services

Solution providers

Digital & mobile services

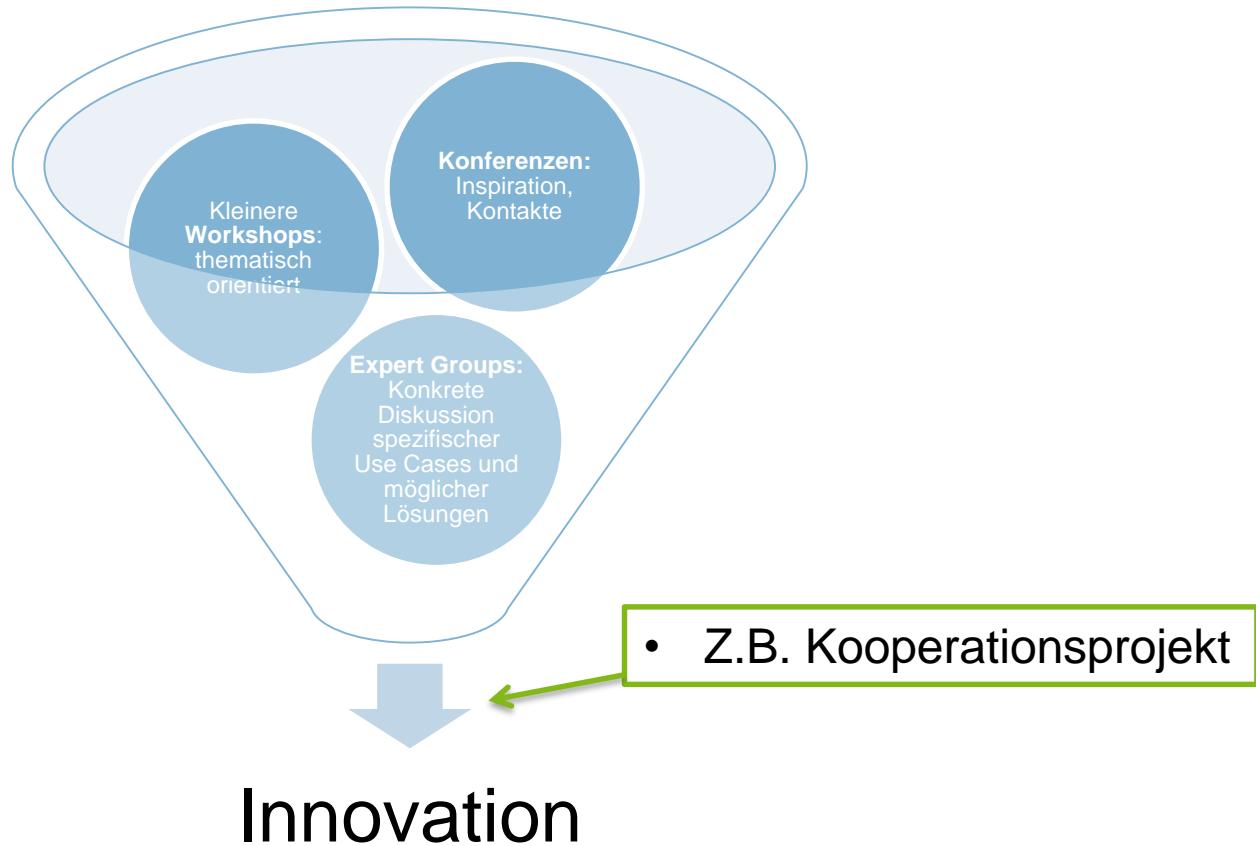
National & international partners

Academic members

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.)



Approach

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



Text based

Segmentation based on textual features and neural nets

Approach

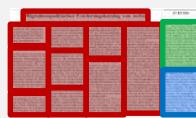
- Text block clustering (semantic distance) based on [2]

Pros

- Rules can be learned implicitly
- Not layout dependent

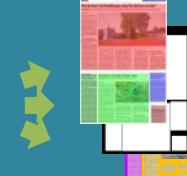
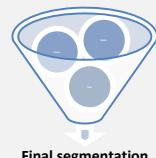
Cons

- Only text can be processed



Combination

Combination of rules, visual and textual features



Result

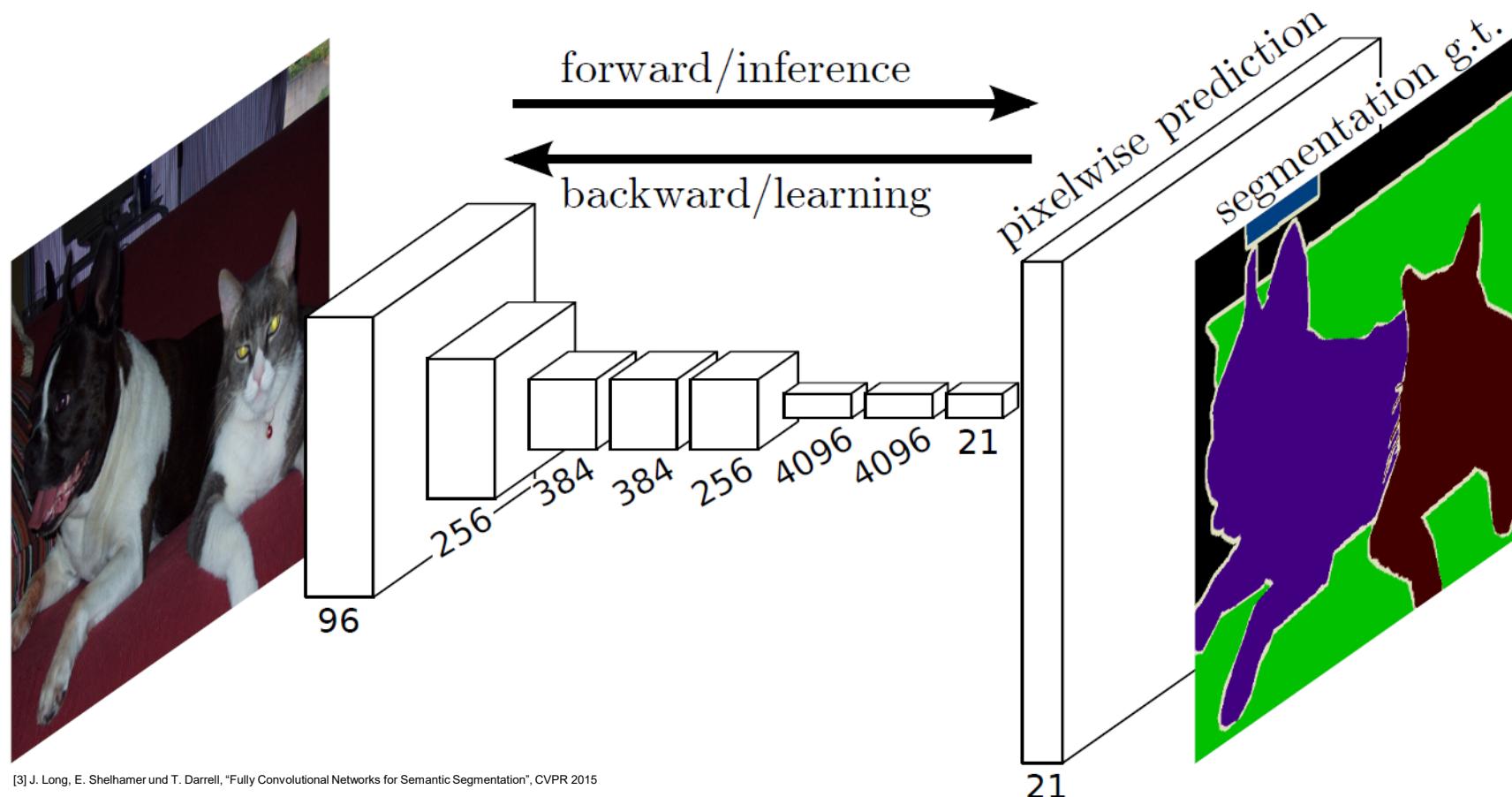
[1] D. Ciresan, A. Giusti, L. M. Gambardella, and J. Schmidhuber. Deep neural networks segment neuronal membranes in electron microscopy images. In NIPS, pages 2852–2860, 2012.

[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.

References

Erweiterung: Semantische Segmentierung

Projektbeispiel (contd.)



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

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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



Swiss Alliance for
Data-Intensive Services

- Service Design Lab
 - 1-2 days in Schloss Thun
 - Professional coaching
 - Provided by Mobiliar
- Smart Factory Lab
 - Smart factory showcase
 - Featuring Swiss technology
 - Culmination point for research
 - Provided by Georg Fischer
Machining Solutions

Swiss Mobiliar
Insurance & Pensions



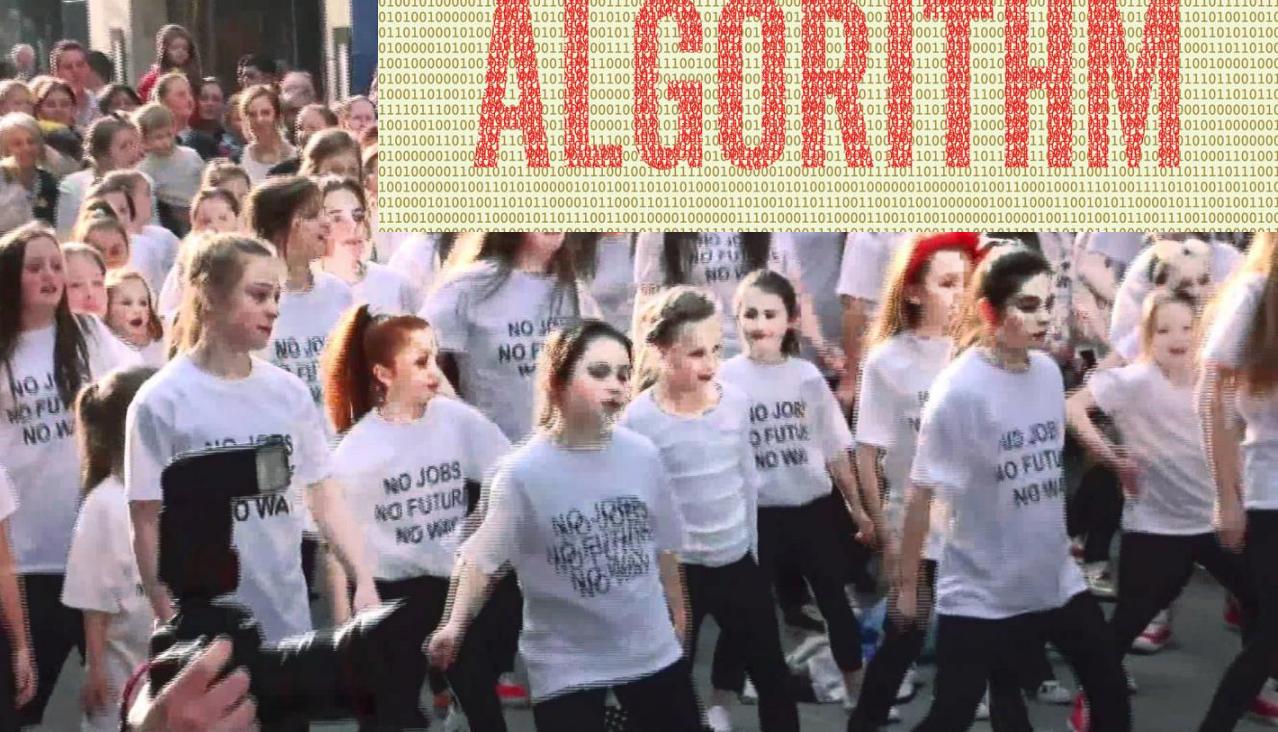
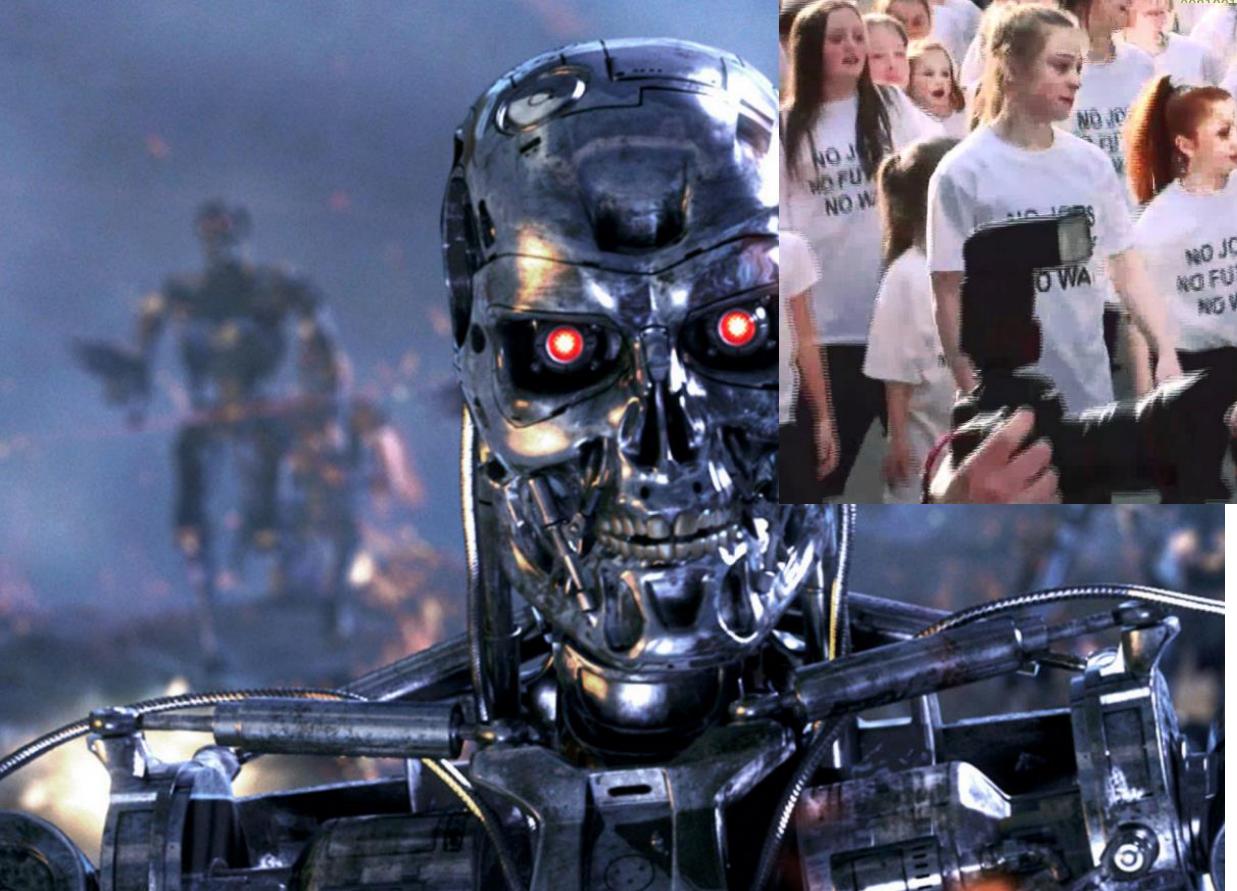
+GF+
GEORG FISCHER



3

Eine Zukunftsprognose

Was ich nicht erwarte



DATA PROTECTION IS A PRIORITY FOR ALL

Was ich erwarte

MODERN DATA SCIENTIST

Data Scientist, the sexiest job of the 21th 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

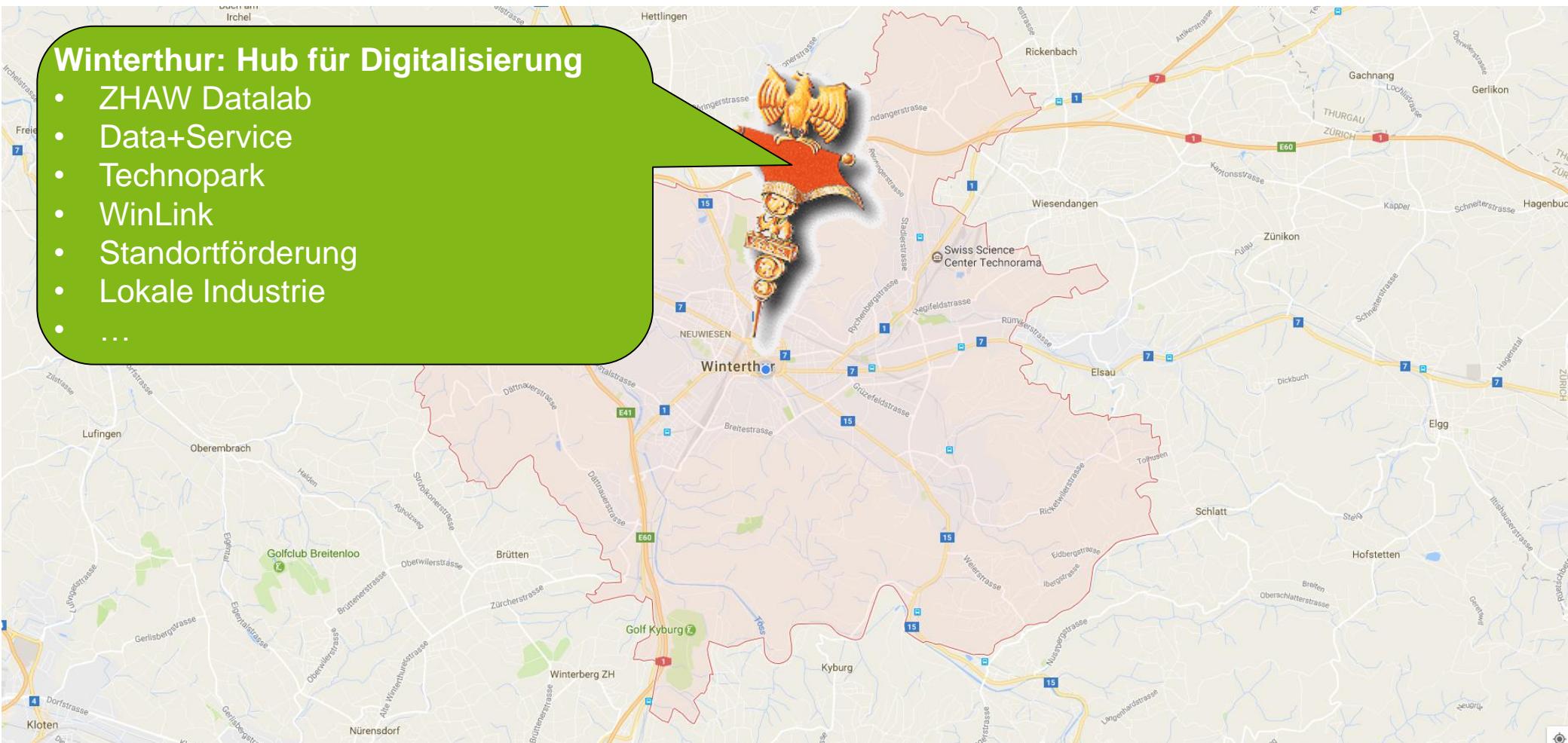


Was ich mir vorstellen kann

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



Swiss Alliance for
Data-Intensive Services

Mehr zu mir:

- Leiter ZHAW Datalab, Boardmitglied Data+Service
- thilo.stadelmann@zhaw.ch
- 058 934 72 08
- www.zhaw.ch/~stdm



Mehr zum Thema:

- Verband Data & Service Science: www.data-service-alliance.ch
- Gemeinsame Projekte: datalab@zhaw.ch

➔ Fragen Sie gerne an.