



Universität St.Gallen

Big Data und KI und deren Einfluss auf die Energiebranche

Stephan Aier

From insight to impact.

School of Computer Science (SCS-HSG)



SCS

- Founded on August 1, 2020
- 14 professors from seven countries
- Women's quota 1/3
- Deeply integrated into the HSG with "Entrepreneurial Computer Science"

Topics

- Data Science and Natural Language Processing
- Artificial Intelligence and Machine Learning
- Software and Systems Engineering, Programming
- Interaction- and Communication-Based Systems
- Cybersecurity
- Human Computer Interaction

School of Computer Science (SCS-HSG)



Research/Teaching

- Approx. 100 employees from approx. 17 countries
- Bachelor's, Master's and doctorate in Computer Science
- Numerous research projects, funded by the Swiss National Science Foundation, EU funding programs, Innosuisse and industrial partners, among others

Institute of Computer Science in Vorarlberg (ICV-HSG)

frei
raum
für neu
gier.



Prof. Dr. Bruno Rodrigues
Assistant Professor of Embedded Sensing Systems



Dr. Bernhard Bermeitinger
Senior Lecturer of Big Data Infrastructures



From Insight to Impact

ICV-HSG Partners in Vorarlberg (and beyond)



HABERKORN



ALPLA



Agenda

1	AI, Big data and Use Cases	7
2	Ingredients: What was necessary for those use cases	18
3	Learning: What are implications for organizations	25

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1	AI, Big data and Use Cases	7
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Where are we currently?

Top Ten Largest IT Investments of Organizations

Organizations' Most Important IT

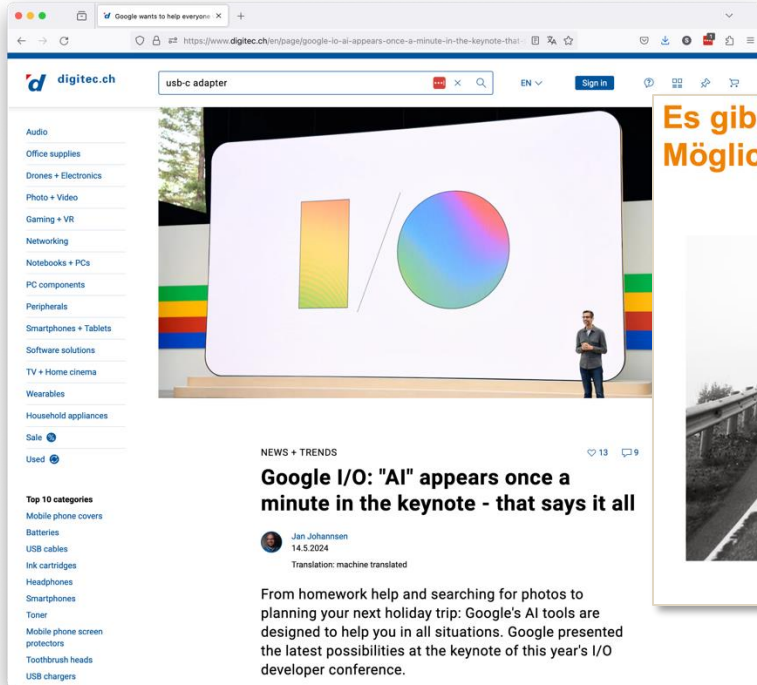
Organizational IT Issue	2023 (n= 436)	2022 (n= 540)	2021 (n= 454)	2020 (n= 624)
Alignment of IT with the Business	1 (44.7%)	2 (33.9%)	2 (33.3%)	2 (35.1%)
Security/Cybersecurity/Privacy	2 (41.7%)	1 (51.1%)	1 (42.5%)	1 (36.1%)
Data Analytics/Data Management	3 (27.1%)	3 (28.7%)	3 (24.7%)	3 (25.3%)
Digital Transformation	4 (25.9%)	5 (22.2%)	4 (24.4%)	4 (24.4%)
Compliance and Regulations (e.g., HIPAA, SarBox, SAS70, PCI etc.)	5 (21.8%)	4 (28.3%)	5 (23.6%)	4 (24.4%)
AI/Expert Systems/Machine Learning	6 (20.4%)	22 (9.6%)	23 (7.5%)	16 (10.1%)
Cost Reduction/Control - IT	7 (19.0%)	17 (11.5%)	10 (15.6%)	6 (23.7%)
Business Continuity	8 (18.3%)	7 (17.8%)	7 (19.2%)	7 (22.8%)
Cost Reduction/Control - Business	9 (17.7%)	14 (13.7%)	13 (13.2%)	8 (19.4%)
Cloud/Cloud Computing	10 (15.8%)	8 (16.9%)	6 (19.4%)	9 (18.3%)

IT Leaders' Most Important

Organizational IT Issue	2023 (n= 436)	2022 (n= 540)	2021 (n= 454)
Security/Cybersecurity/Privacy	1 (44.5%)	1 (55.2%)	1 (46.9%)
IT Talent/Skill Shortage/Retention	2 (27.1%)	2 (38.1%)	3 (22.2%)
Alignment of IT and/with the Business	3 (26.8%)	3 (25.2%)	2 (24.4%)
AI/Expert Systems/Machine Learning	4 (24.3%)	27 (6.5%)	32 (5.3%)
Credibility of IT/Perception of IT Leadership	5 (20.9%)	6 (17.8%)	4 (21.6%)
Compliance and Regulations (e.g., HIPAA, SarBox, SAS70, PCI etc.)	6 (19.3%)	4 (19.4%)	6 (16.5%)
Business Continuity	7 (17.7%)	5 (19.3%)	5 (17.4%)
Improving IT Communications and Relationships with the Business	8 (15.8%)	11 (13.7%)	11 (11.7%)
Cost Reduction/Control - IT	9 (15.6%)	25 (8.3%)	16 (10.4%)
Data Analytics/Data Management	10 (15.4%)	7 (15.2%)	9 (14.1%)

IT Investment Area	2023 (n= 436)	2022 (n= 540)	2021 (n= 454)	2020 (n= 624)	2019 (n= 618)	2018 (n= 793)	2017 (n= 769)	2016 (n= 801)	2015 (n= 785)	2014 (n= 717)	2013 (n= 482)
Analytics/Business Intelligence/Data Mining/Forecasting/Big Data	1 (39.4%)	1 (40.0%)	3 (34.1%)	2 (35.6%)	1 (37.9%)	1 (37.7%)	1 (41.6%)	1 (39.5%)	1 (38.0%)	1 (30.1%)	1 (42.1%)
Security/Cybersecurity	2 (39.0%)	2 (37.2%)	2 (38.8%)	3 (33.0%)	3 (33.3%)	2 (37.1%)	2 (36.2%)	3 (29.5%)	3 (28.9%)	7 (11.9%)	14 (7.5%)
Application Software Development/Maintenance	3 (35.8%)	4 (29.3%)	4 (28.6%)	4 (27.6%)	4 (28.3%)	4 (30.6%)	4 (30.6%)	2 (34.1%)	4 (28.8%)	4 (18.4%)	6 (11.8%)
Cloud Computing (e.g., SaaS, PaaS, IaaS etc.)	4 (34.2%)	3 (36.9%)	1 (43.0%)	1 (38.1%)	2 (36.1%)	3 (33.9%)	3 (31.1%)	4 (27.8%)	7 (22.9%)	5 (15.6%)	3 (18.7%)
ERP (Enterprise Resource Planning)	5 (23.4%)	5 (23.9%)	5 (23.6%)	6 (22.3%)	6 (22.5%)	5 (26.6%)	5 (28.6%)	6 (25.0%)	2 (32.2%)	3 (18.7%)	4 (16.6%)
CRM (Customer Relationship Management)	6 (20.2%)	6 (21.9%)	6 (21.8%)	5 (22.8%)	5 (24.1%)	5 (23.7%)	6 (24.1%)	5 (26.0%)	5 (24.5%)	6 (13.8%)	2 (19.5%)
Legacy Applications - Replacing/Replatforming	7 (18.6%)	7 (14.8%)	7 (17.2%)	7 (15.7%)	7 (18.8%)	9 (15.0%)	9 (15.5%)	11 (13.2%)			
AI/Machine Learning/Expert Systems	8 (13.1%)	15 (10.0%)	17 (9.3%)	15 (9.6%)	12 (10.8%)						
Collaboration Tools	9 (11.5%)	17 (9.3%)	10 (12.1%)	8 (14.6%)	16 (7.9%)	18 (7.2%)	20 (7.5%)	15 (7.6%)	13 (10.7%)	15 (5.6%)	12 (8.1%)
Data Center/Infrastructure	9 (11.5%)	9 (12.2%)	8 (13.0%)	9 (14.3%)	8 (15.4%)	7 (21.9%)	7 (20.9%)	7 (24.7%)	6 (24.2%)	2 (19.1%)	

Where are we currently?



Es gibt viele Ideen, Generative KI mit hoher Nutzenerwartung einzusetzen – Möglichkeiten und Potentiale sind noch auszuleuchten



Die Nutzenerwartung ist sehr hoch - mit großem Zukunftspotential (Chat GPT als KI-Durchbruch?).



Eine schnelle Einführung scheint geboten (und wird erwartet!), um zügig die neuen Potentiale zu nutzen.



Alle Branchen sind am Lernen, wie die Potentiale gehoben und Risiken mitigiert werden können.



Die (technologische) Entwicklung der Generativen KI verläuft aktuell höchst dynamisch.



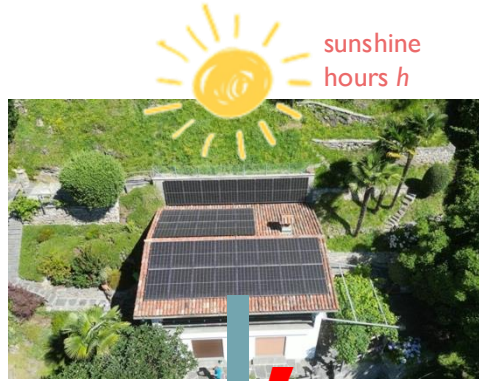
„Fertige“ Einführungskonzepte existieren nicht - auch wenn das teilweise anders kolportiert wird.

B. Reischl-Lenz: Generative KI @ DZ BANK AG, 30th DMAC Workshop, Zurich, Dec. 2023.

Which problem is Machine Learning trying to solve (with Big Data)?



Source: Mad Magazine/20 Minuten



Source: <https://www.elia.ch/de/aktuell>



Source: Audi

Can Albert charge his
EV with his PV energy
in his home office
tomorrow?

34 PV modules
each module: 1.7m x 1.1m
→ 64 m² PV area

sun radiation energy: 1kW/m²
efficiency factor PV modules: 20%

production power: 12.8 kW

Input → model output →
 $x \text{ h} \rightarrow x \text{ h} * 12.8 \text{ kW} \rightarrow y \text{ kWh}$

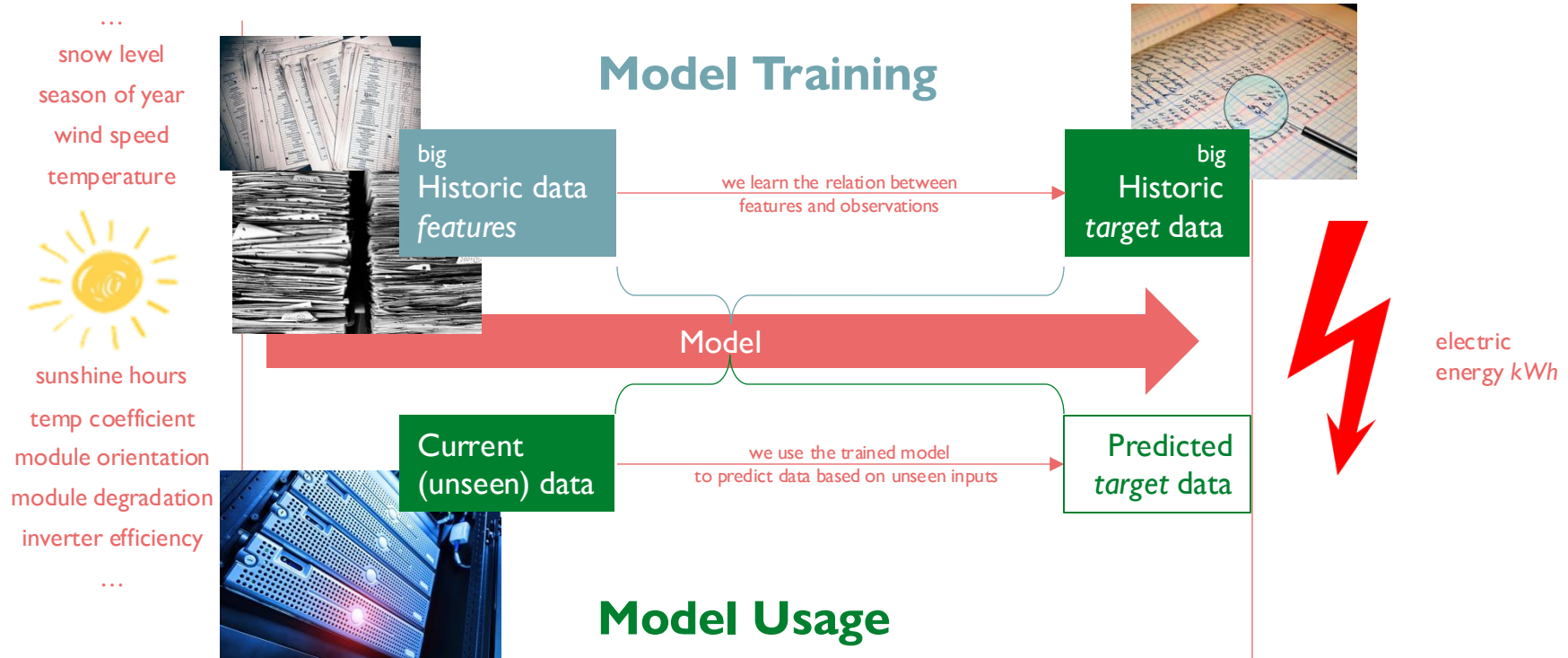
x sunshine hours tomorrow
 $x = 9\text{h}$

y electric energy production forecast
 $y = 115 \text{ kWh}$ (very much simplified)

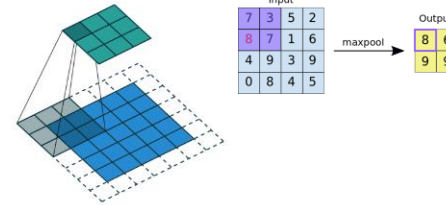
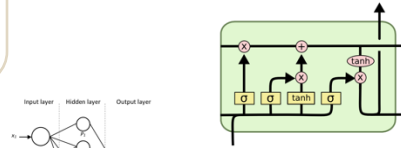


Source: Meteo Schweiz app

How does Machine Learning solve the problem (with Big Data)?



Can we **predict** SGSW's Photovoltaic Energy production so as to **enable SGSW to buy on the Day-Ahead Market instead of the Spot Market?**



Fehlermass	Baseline	CNN-LSTM	%-Delta
CPE	57.4%	37.6%	- 19.8%
RMSE	0.134	0.079	- 41.04%
MAE	0.059	0.038	- 35.59%
R ²	51.1%	83.1%	+ 32%

940'000

Baseline Error
[CHF]

—

605'000

Model Error
[CHF]

=

335'000

Savings
[CHF]

Dynamic Load Management

von Marco Birchler, Davide Donati, Maxime Flèche, Bo Simon
(Advisor: Dr. Bernhard Bermeitinger)



AKTUELLER STAND

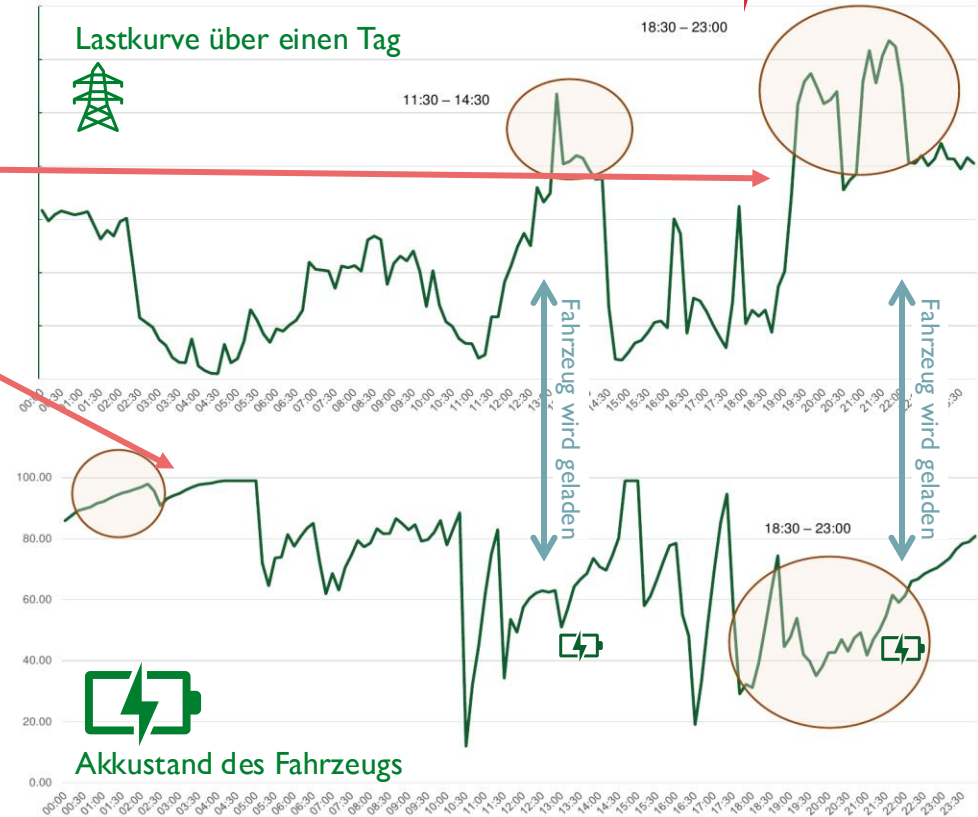
- E-Autos werden um 20:00 angesteckt
 - Akkus vollständig geladen ab 02:00
- ⇒ Hohe Last zwischen 20:00 – 02:00
⇒ Kaum Last zwischen 02:00 – 06:00

DYNAMISCHES MANAGEMENT

- Verschiebung der Ladezeiten **dynamisch** auf Downzeiten
- **Forecast-basiert**
- **Kundenzentrisch**

KUNDENSTEUERUNG

- «Das Auto soll um 6:00 aufgeladen sein.»
- «Das Auto soll um 7:30 zu mindestens 60% aufgeladen sein, wenn der Strompreis über 20 Rp./kWh liegt.»



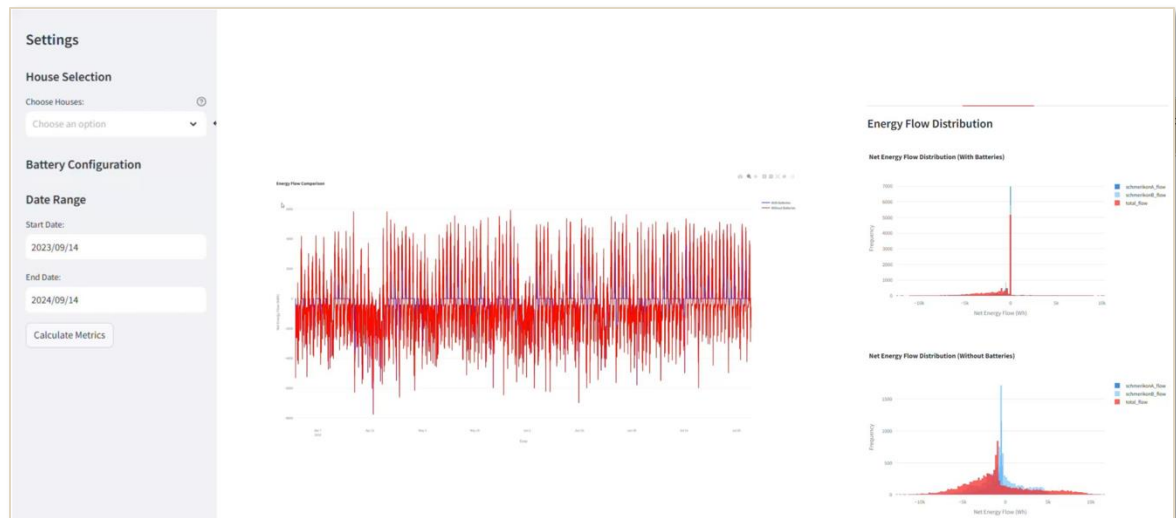
Energiegemeinschaften seit 2025

von Moritz Fässler und Marcel Hollenstein (Advisor: Prof. Stephan Aier)

SAK

- EW-Netz, Netzebene 5/7**
- EW-Zähler
- Max. 30 % Rabatt auf Netznutzung

- 2.3 Rp/kWh*



Zähler EW/
Verteilnetzbetreiber

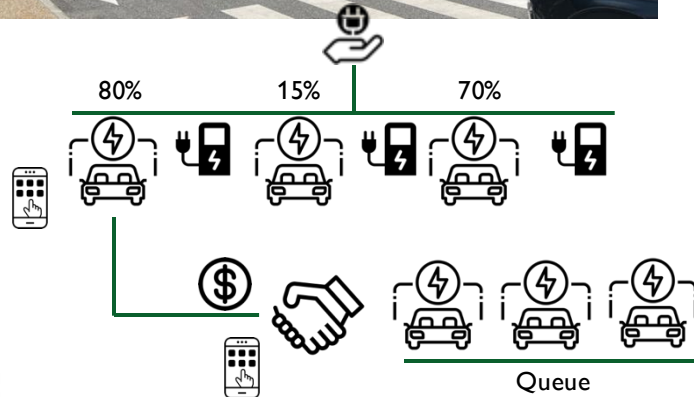


Virtueller Zählerpunkt
EW/Verteilnetzbetreiber



LEG

An Online Game Theory Approach to Optimize Charging Station Turnover During Peak Demand



SCENARIO

Increasing demand for Electric Vehicle (EV) charging stations (CS)

Charging rate is inversely proportional to state of charge

PROBLEM

Provider perspective: low CS turnover at peak demand

Customer perspective: dissatisfied due to waiting queues

APPROACH

Map the scenario as a game where **Nash equilibrium** is obtained by:

- EV1 at the queue: provide incentives to use CS
- EV2 using CS: release CS satisfied with incentives
- Provider: increase CS turnover, therefore, income

CHALLENGES

Proof of commitment, user privacy, malicious users, latency and scalability, queue management

Warranty Management

von Fabian Rinderer and Ben Mulder (Advisor: Dr. Bernhard Bermeitinger)

TRIDONIC

MOTIVATION

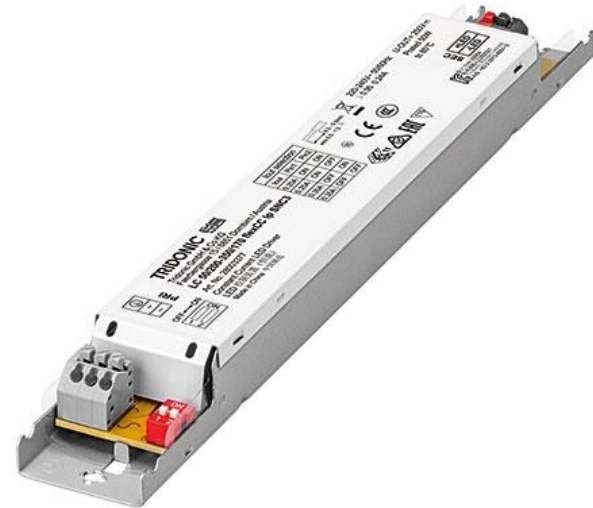
- They sell lightning solutions.
- Business question:
“Is it beneficial for us to offer **extended** guarantee?”
(Meaning, does a certain product break before or after five years?)

METHODS

- Multitude of different approaches: OLS, Deep Sets, GMM, Supervised, SHAP
- Predictions on **distributions** rather than individual items

OUTCOMES AND FINDINGS

- Data collection not sufficient
- However:
 - Strong indicator that extended guarantee can be offered
 - Or rather: No indication that the extended guarantee cannot be sold.



Anomalien akustisch feststellen und lokalisieren

Rodundwerk II



(Advisor: Prof. Bruno Rodrigues)

PROBLEM

Können wir mit akustischen Sensoren (Mikrophone) Anomalien im Kraftwerk

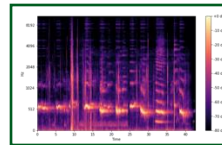
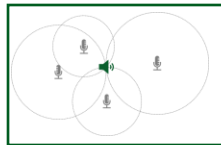
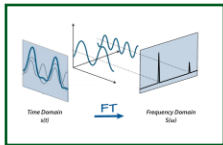
- detektieren
- klassifizieren
- lokalisieren?

HERAUSFORDERUNGEN

- polyphone Umgebung, Störgeräusche
- Schallreflektionen, Mehrwege-Schallausbreitung, Interferenzen

ANSATZ

- Aufbereitung und Filterung von Audiosignalen
- Training eines Machine-Learning-Klassifikators
- Echtzeit-Erkennung von Anomalien durch die „Geräusche“ des Kraftwerks



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What was necessary for those use cases?



What did it take to make it happen?

- Business opportunity / problem / potential value
- Data access and data quality
- Data governance and data culture
- Integration into operational systems
- Resources!

How do we generate BUSINESS VALUE from AI?

Wen, wie und warum bilden wir an der HSG aus?

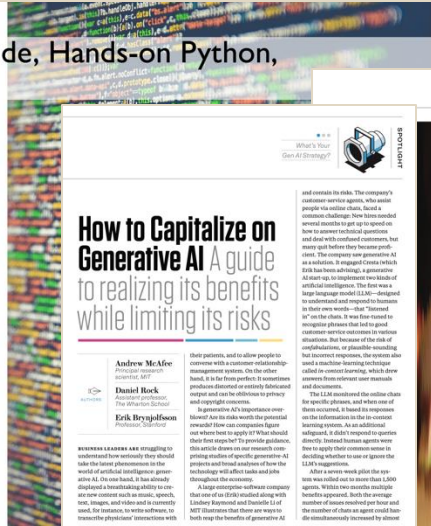
Jedes Semester, 500 BWL-Studierende, Hands-on Python, Data Science, Machine Learning

Ziel

- Studierende mit **CS-Implementierungs-Skills** ausstatten
- In die Lage versetzen, selbständig fortgeschrittene **Programme zu entwickeln**
- **Businessprobleme** mit CS-Techniken **lösen**

Inhalt

- Einführung in die **Python-Programmierung**
- und Anwendung in
 - **Netzwerke und verteilte Systeme,**
 - **Datenbanken,**
 - und **Data Science und Machine Learning.**

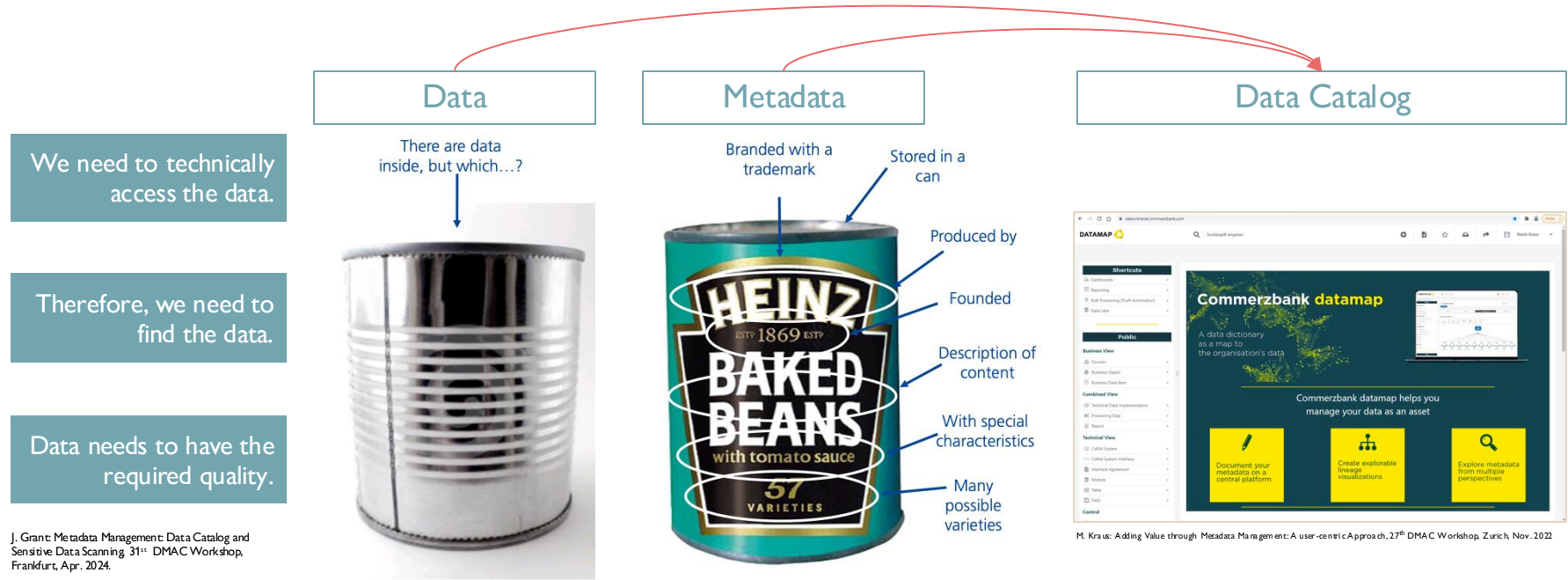


A. McAfee, D. Rock, and E. Brynjolfsson: How to Capitalize on Generative AI, Harvard Business Review, Nov-Dec. 2023.



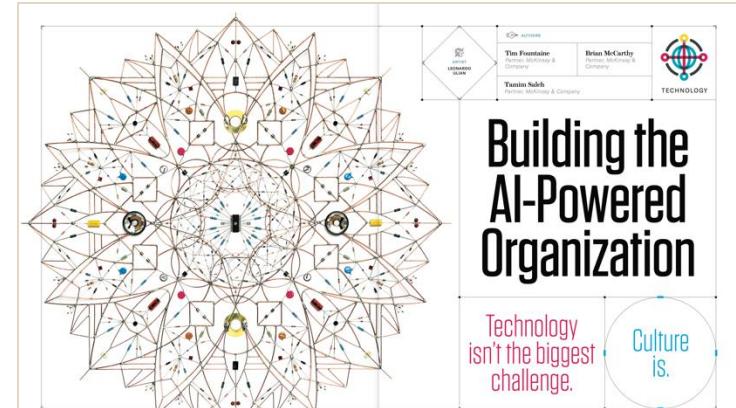
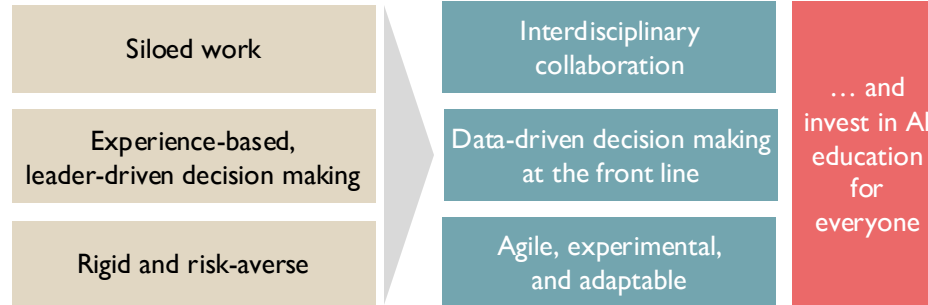
B. Babic, D.L. Chen, T. Evgeniou, and A.-L. Fayard: Stop A Better Way to Onboard AI, Harvard Business Review, Jul-Aug. 2020.

How do we find (appropriate) data (quickly)?

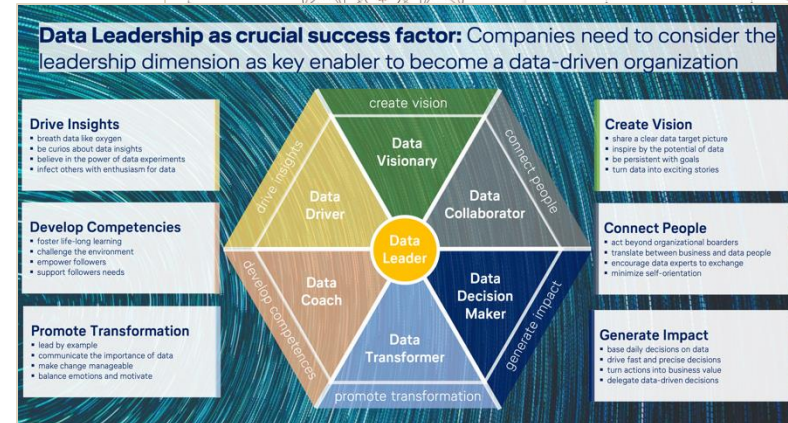


Data descriptions (that is meta data) to find data and to find out, whether they are **appropriate** (fit) for a certain **purpose**.

How do we anchor Data/AI-Thinking in our organization?



B. Reischl-Lenz: Generative KI @ DZ BANK AG, 30th DMAC Workshop, Zurich, Dec. 2023.



C. Haude: Data Leadership – Update, 29th DMAC Workshop, St. Gallen, Jun. 2023.

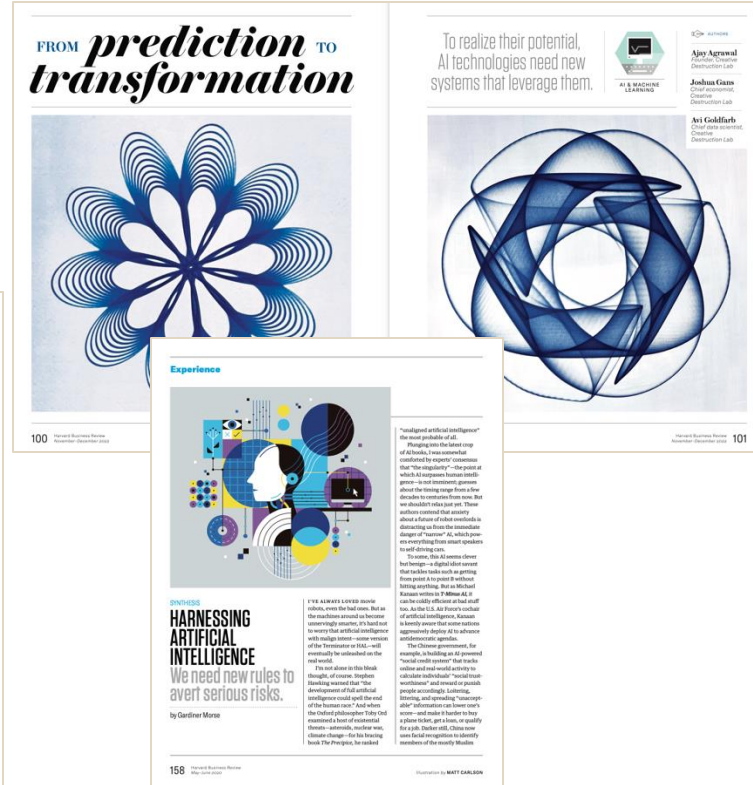
How do we access, use, and interact with AI systems?



Hypothese 2: Die DZ BANK verfolgt drei technologische Stränge zur Bereitstellung von KI



B. Reischl-Lenz: Generative KI @ DZ BANK AG, 30th DMAC Workshop, Zurich, Dec. 2023.



G. Morse: Harnessing Artificial Intelligence, Harvard Business Review, May-Jun. 2020.

What is really needed now?

Resources!

Prototypes

We need much more exploration / fail early approaches

(what data do we have / do we need, will results be good enough, is the risk acceptable, ...?)

People

We need people with capacity and knowledge / understanding for AI

(and I don't just talk about computer scientists, I talk about "businesspeople")

Technology

A technology platform for exploration, a playground

(and we probably need it first, i.e., the first use cases will have a terrible business case)

There is **no** such thing as a **free lunch**.

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It is probably not a sprint

When can we have it?

Analytics And Data Science

If Your Company Isn't Good at Analytics, It's Not Ready for AI

by Nick Harrison and Deborah O'Neill

Technology And Analytics

Is Your Company's Data Ready for Generative AI?

by Thomas H. Davenport and Priyanka Tiwari

March 26, 2024



B. Reischl-Lenz: Generative KI @ DZ BANK AG, 30th DMAC Works

C. Haude: Data Leadership – Update, 29th DMAC Workshop, St. Gallen, Jun. 2023.

It will be a **learning journey** – for the organization as well as for its individuals.

So what?

Which of those ingredients are of infrastructural character?

What did it take to make it happen?

- ? Business opportunity / problem / potential value
- ✓ Data access and data quality
- ✓ Data governance and data culture
- ? Integration into operational systems
- ✓ Resources!

What are the implications?

- It will be expensive – first of all
- The returns will be atomic ... but will accumulate over time
- We need adoption anyway



T.H Davenport; N. Mitral: Stop Tinkering with AI, Harvard Business Review, Jan-Feb. 2023.



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Director, Professor, Senior Lecturer

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***"From insight
to impact"*** 