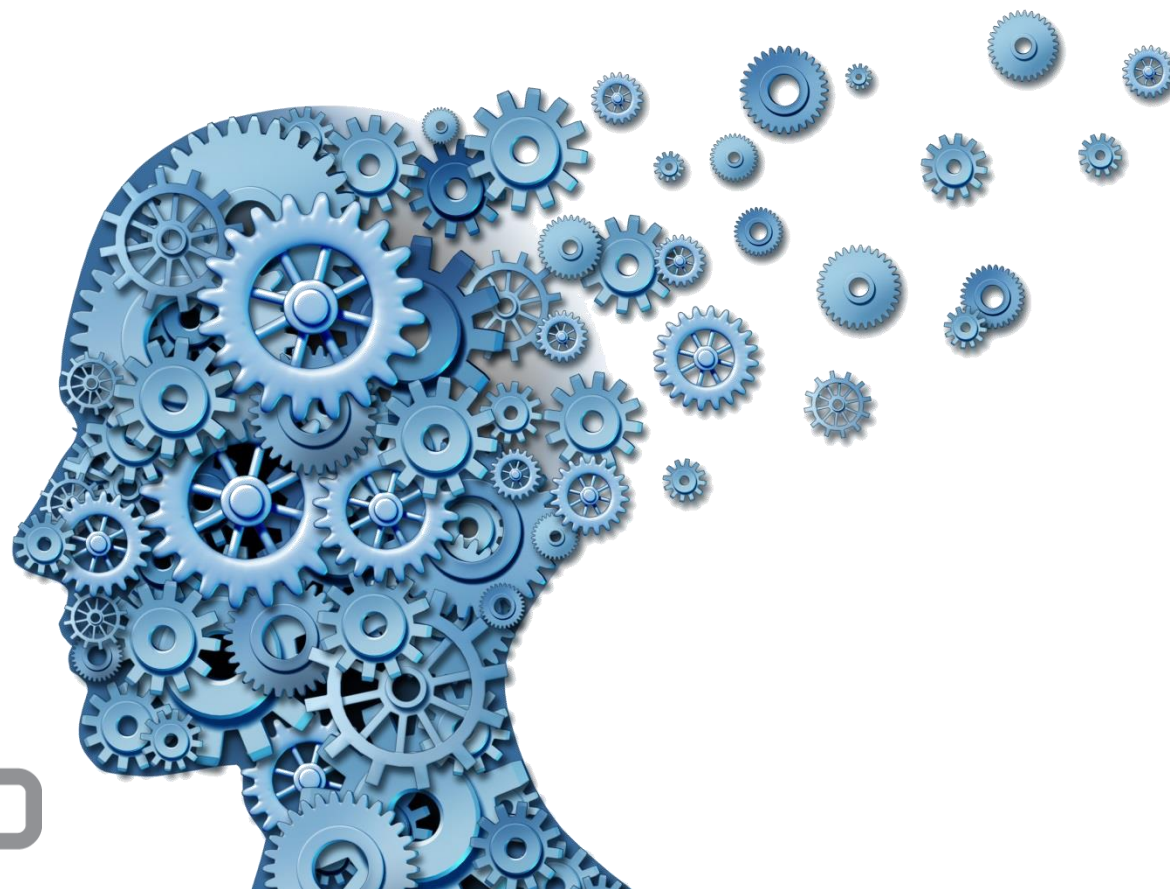


Report from the Front Lines of Deep Learning

Deep Learning Workshop, Bern, June 06, 2018

Thilo Stadelmann



Swiss Alliance for
Data-Intensive Services

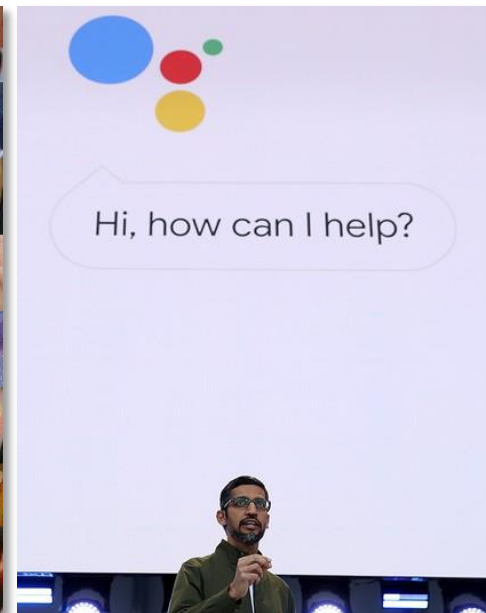
swiss group for artificial intelligence
and cognitive science



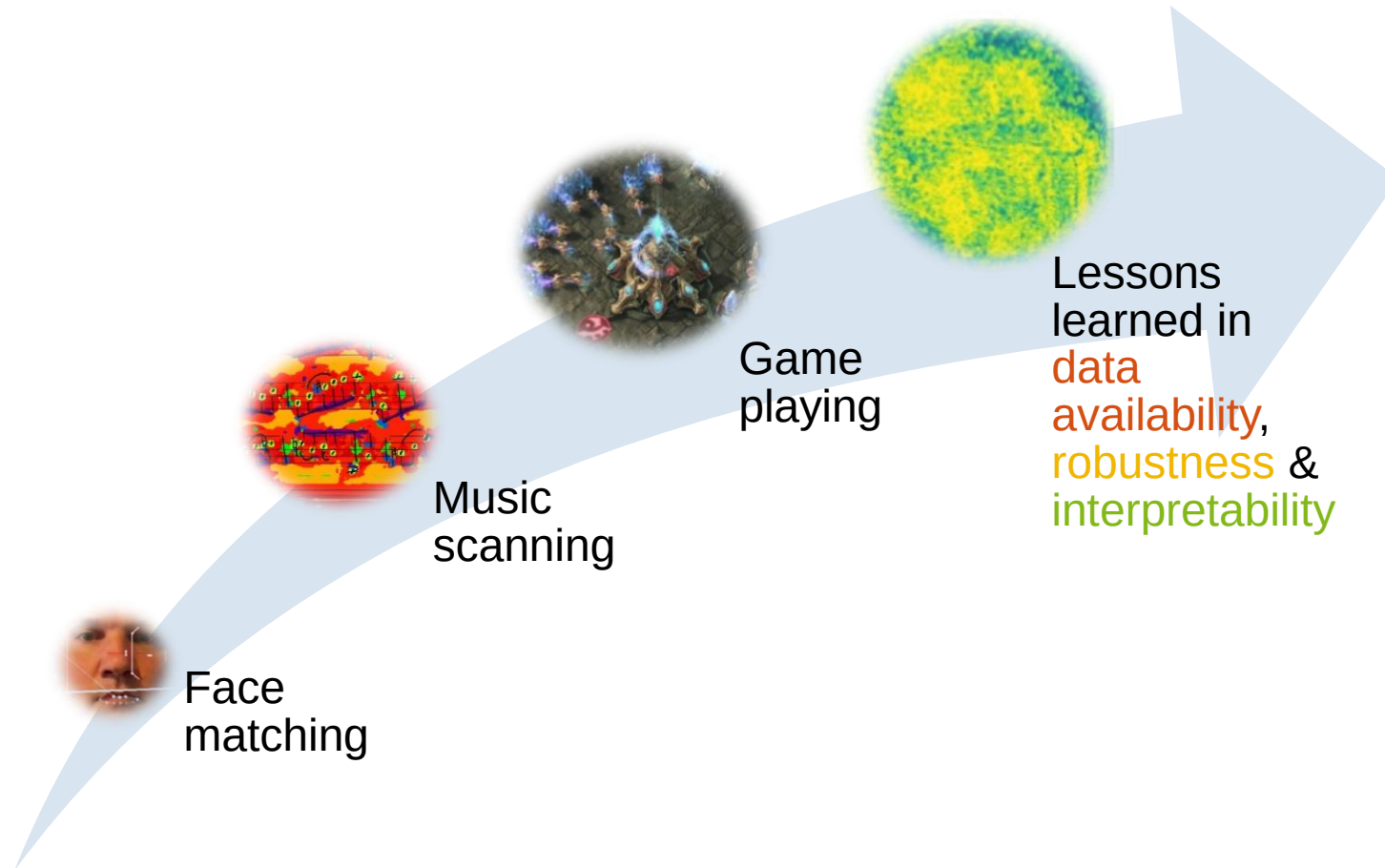
datalab

www.zhaw.ch/datalab

Why?



Agenda



Face matching



[!] DEEPIIMPACT



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Innosuisse – Swiss Innovation Agency

Face matching



[!] DEEPIMPACT



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Innosuisse – Swiss Innovation Agency

Music scanning

N 132.
Die Forelle.
Gedicht von Ch. F. D. Schubert.
Für eine Singstimme mit Begleitung des Pianoforte.
Schubert's Werke. comp. v. Sch. 1827.
Franz Schubert.
Dreise Facsimile.
Nº 231.

Melodie:
Singstimme:
Pianoforte:



```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE score-partwise SYSTEM "http://www.musescore.org/dtd/partwise.dtd" PUBLIC "-//Recordare//DTD MusicXML 2.0
Partwise/EN"
- <score-partwise>
- <identification>
- <encoding>
- <software> MuseScore 1.3 </software>
- <encoding-date> 2014-12-16 </encoding-date>
- <encoding>
- <source> http://musescore.com/score/502006 </source>
- <identification>
- <defaults>
- <scaling>
- <millimeters> 7.056 </millimeters>
- <cenths> 40 </cenths>
- <scaling>
- <page-layout>
- <page-height> 1683.67 </page-height>
- <page-width> 1190.48 </page-width>
- <page-margins type="even">
- <left-margin> 56.6893 </left-margin>
- <right-margin> 56.6893 </right-margin>
- <top-margin> 56.6893 </top-margin>
- <bottom-margin> 113.379 </bottom-margin>
- </page-margins>
- <page-margins type="odd">
- <left-margin> 56.6893 </left-margin>
- <right-margin> 56.6893 </right-margin>
- <top-margin> 56.6893 </top-margin>
- <bottom-margin> 113.379 </bottom-margin>
- </page-margins>
- </page-layout>
- </defaults>
- <credit page="1">
- <credit-words valign="top" justify="center" font-size="24" default-y="1626.98" default-x="595.238"> Die
Forelle </credit-words>
- </credit>
- <credit page="1">
- <credit-words valign="top" justify="right" font-size="12" default-y="1557.22" default-x="1133.79"> Franz
Schubert </credit-words>
- </credit>
- <credit page="1">
- <credit-words valign="bottom" justify="center" font-size="8" default-y="113.379" default-x="595.238"> Franz
Schubert, Die Forelle (Hörsände on http://www.Musescore.com) </credit-words>
- </credit>
- <part-list>
- <score-part id="P1">
- <part-name> Ténor </part-name>
- <part-abbreviation> Ténor </part-abbreviation>
- <score-instrument id="P1-13">
- <instrument-name> Ténor </instrument-name>
- </score-instrument>
- <midi-instrument id="P1-13">
- <midi-channel> 1 </midi-channel>
- <midi-program> 74 </midi-program>
- <volume> 78.7402 </volume>
- <pan> 0 </pan>
- </midi-instrument>
- </score-part>
- <part-group type="start" number="1">
- <group-symbol> brace </group-symbol>
- </part-group>
- <score-part id="P2">
- <part-name>
- <score-instrument id="P2-13">
- <instrument-name>
```

Zürcher Hochschule
für Angewandte Wissenschaften

zhaw

SCOREPAD



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Innosuisse – Swiss Innovation Agency



Die Forelle - Franz Schubert

$\text{♩} = 80$

Voice

Piano

Vo.

ei - nem Büch-lein hel - le, da schoß in fro - her Eil die lau - ni - sche Fo - re - le vor -

Music scanning – challenges & solutions



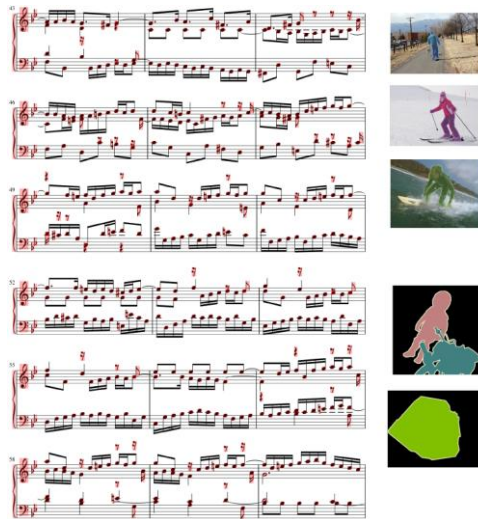
SCOREPAD



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Innosuisse – Swiss Innovation Agency

Tuggener, Elezi, Schmidhuber, Pelillo & Stadelmann (2018). «DeepScores – A Dataset for Segmentation, Detection and Classification of Tiny Objects». ICPR'2018.

Music scanning – challenges & solutions



SCOREPAD



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra
Swiss Confederation
Innosuisse – Swiss Innovation Agency

Tuggener, Elezi, Schmidhuber, Pelillo & Stadelmann (2018). «DeepScores – A Dataset for Segmentation, Detection and Classification of Tiny Objects». ICPR'2018.

Music scanning – challenges & solutions

(a) accidentalSharp

(b) keySharp

(c) augmentationDot

(d) articStaccatoAbove

Tuggener, Elezi, Schmidhuber, Pelillo & Stadelmann (2018). «DeepScores – A Dataset for Segmentation, Detection and Classification of Tiny Objects». ICPR'2018.

Music scanning – challenges & solutions

(a) accidentalSharp (b) keySharp

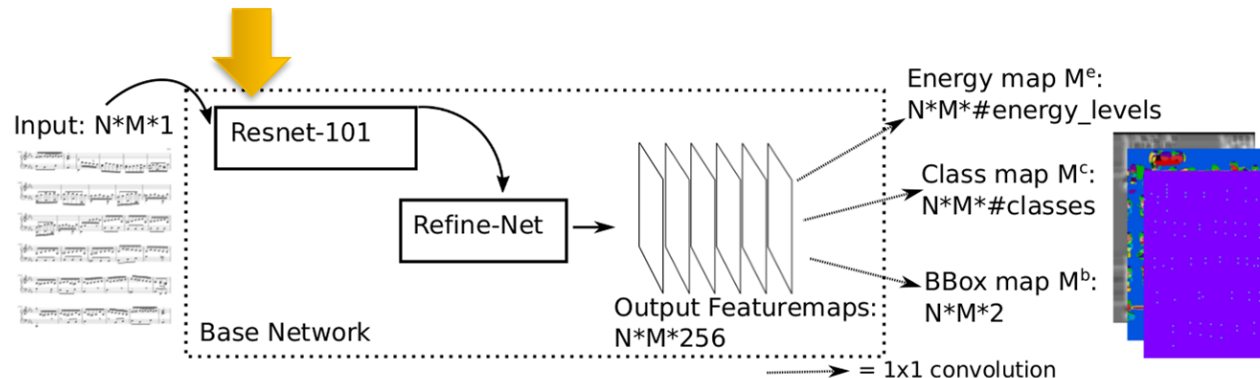
(c) augmentationDot (d) articStaccatoAbove

Tuggener, Elezi, Schmidhuber, Pelillo & Stadelmann (2018). «DeepScores – A Dataset for Segmentation, Detection and Classification of Tiny Objects». ICPR'2018.

Music scanning – challenges & solutions

(a) accidentalSharp (b) keySharp

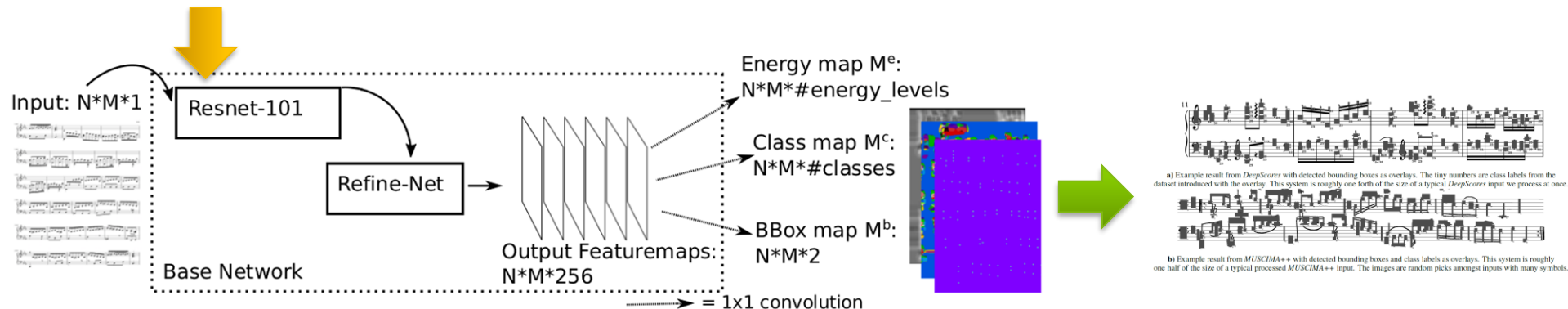
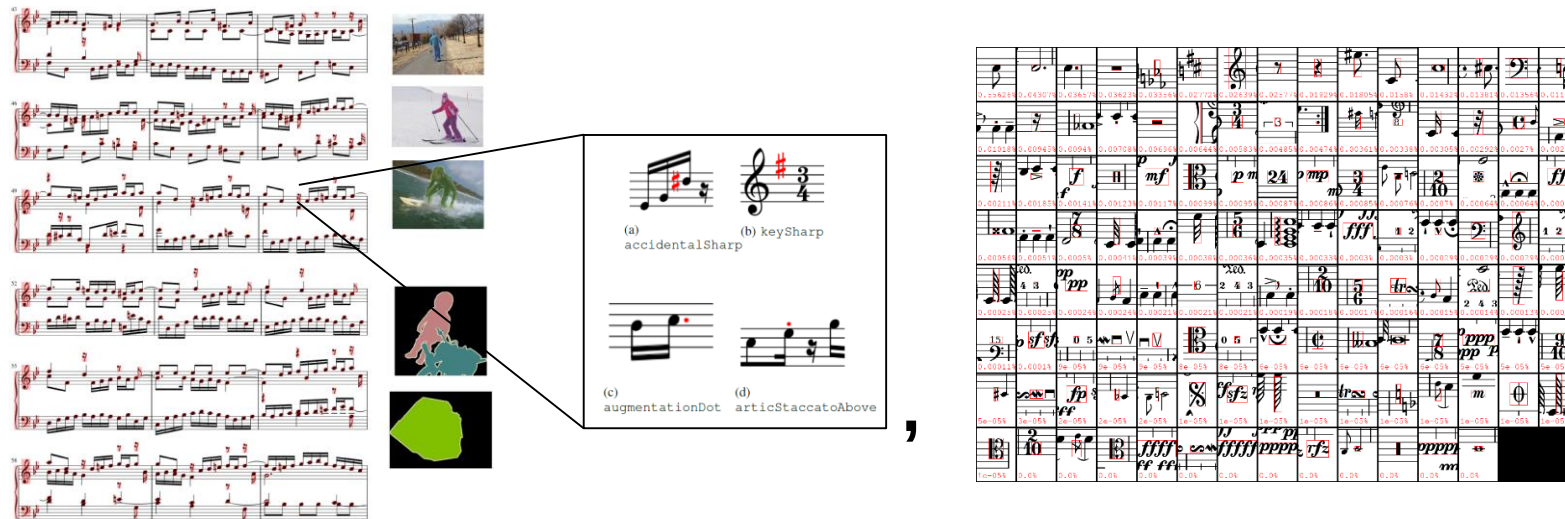
(c) augmentationDot (d) articStaccatoAbove



Tuggener, Elezi, Schmidhuber, Pelillo & Stadelmann (2018). «DeepScores – A Dataset for Segmentation, Detection and Classification of Tiny Objects». ICPR'2018.

Tuggener, Elezi, Schmidhuber & Stadelmann (2018). «Deep Watershed Detector for Music Object Recognition». ISMIR'2018.

Music scanning – challenges & solutions



Tuggener, Elezi, Schmidhuber, Pelillo & Stadelmann (2018). «DeepScores – A Dataset for Segmentation, Detection and Classification of Tiny Objects». ICPR'2018.

Tuggener, Elezi, Schmidhuber & Stadelmann (2018). «Deep Watershed Detector for Music Object Recognition». ISMIR'2018.

Game playing

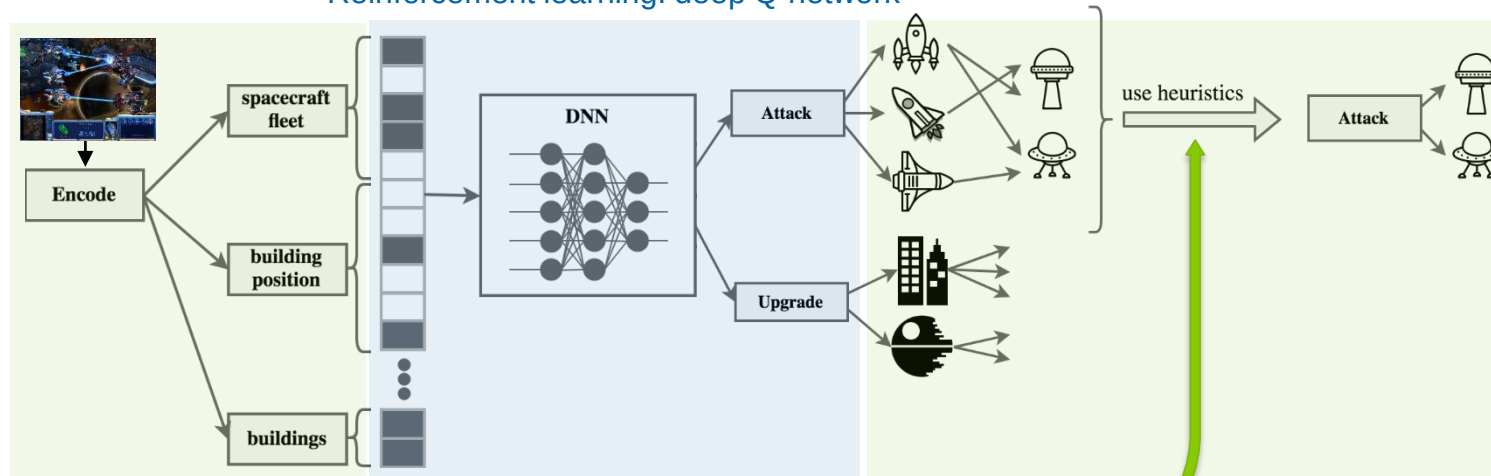


(symbolic figure)



Game playing – challenges & solutions

Reinforcement learning: deep Q network



Large discrete action space → use heuristic

- makes exploration difficult
- elongates training time

Delayed and sparse reward → do reward shaping

- sequence of actions crucial to get a reward



Distance encoding → use reference points

Transfer Learning → difficult: more complex environment needs other action sequence

Stadelmann, Duivesteyn, Amirian, Tuggener, Elezi, Geiger & Rombach (2018). «Deep Learning in the Wild». ANNPR'2018.

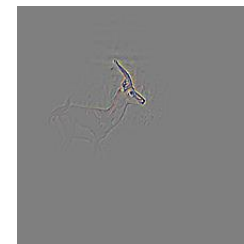
Lessons learned

Data is key.

- Many real-world projects miss the required **quantity & quality** of data
→ even though «big data» is not needed
- **Class imbalance** needs careful dealing
→ special loss, resampling (also in unorthodox ways)

Robustness is important.

- **Training processes** can be tricky, both in deep- and reinforcement learning
→ give hints via a unique loss, reward shaping and preprocessing
- **Risk minimization** instead of error minimization
→ detect all defects at the expense lower precision



Lessons learned – model interpretability

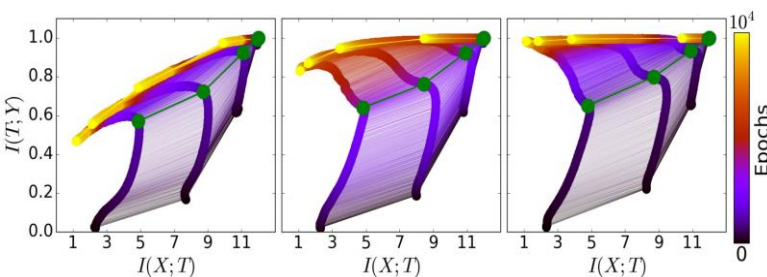
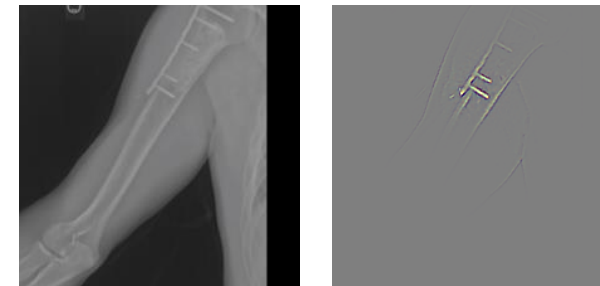
Interpretability is required.

- Helps the developer in «debugging», needed by the user to trust
→ visualizations of learned features, training process, learning curves etc. should be «always on»

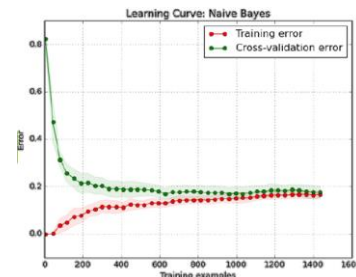
negative X-ray



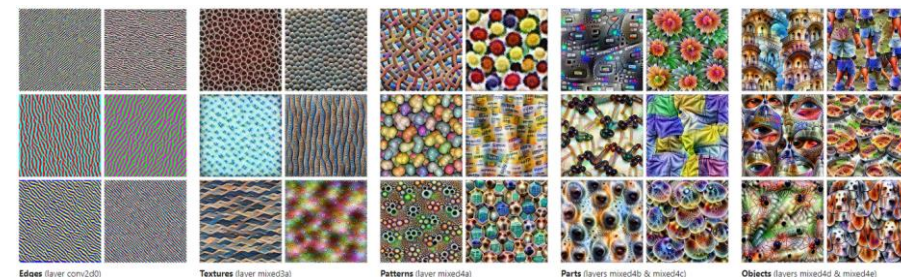
positive X-ray



DNN training on the Information Plane



a learning curve



feature visualization

Schwartz-Ziv & Tishby (2017). «Opening the Black Box of Deep Neural Networks via Information».

<https://distill.pub/2017/feature-visualization/>, <https://stanfordmlgroup.github.io/competitions/mura/>

Stadelmann, Duivesteijn, Amirian, Tuggener, Elezi, Geiger & Rombach (2018). «Deep Learning in the Wild». ANNPR'2018.

Conclusions

- Deep learning **is applied** and deployed in «normal» businesses (non-AI, SME)
- It does not need big-, but some **data (effort usually underestimated)**
- DL/RL **training** for new use cases **can be tricky** (→ needs thorough experimentation)
- New **theory and visualizations** help to debug & understand
 - *the training process*
 - *individual results*



On me:

- Head ZHAW Datalab, vice president SGAICO, board Data+Service
- thilo.stadelmann@zhaw.ch
- 058 934 72 08
- <https://stdm.github.io/>



On the topics:

- AI: <https://sgaico.swissinformatics.org/>
- Data+Service Alliance: www.data-service-alliance.ch
- Collaboration: datalab@zhaw.ch

→ Happy to answer questions & requests.