Master Seminar:

Practical Applications of Deep Learning

Joseph Bethge, Ziyun Li, Hendrik Rätz, Jona Otholt, Gregor Nickel, PD Dr. Haojin Yang
Multimedia and Machine Learning Group
Chair of Internet Technologies and Systems
Hasso Plattner Institute, University of Potsdam

Content

- **Teaching team**
- Topics
- Important information

Personal Information

Joseph Bethge, M.sc

- Research background
  - 2010~2013 Bachelor Degree (Hasso-Plattner-Institute)
  - 2014~2017 Master Degree (Hasso-Plattner-Institute)
  - 2017~ PhD Student at Hasso-Plattner-Institute
- Research interests
  - Computer vision, deep learning, binary neural networks
  - Meanwhile promoting reproducibility and Open Source code

Personal Information

Hendrik Rätz, M.Sc.

- Research background
  - 2014-2017 Bachelor Degree (Hasso Plattner Institute)
  - 2017-2021 Master Degree (Hasso Plattner Institute)
  - 2021 PhD Student at Hasso Plattner Institute
- Research interests
  - Computer vision, self-supervised learning, text/handwriting recognition

Personal Information

Jona Otholt, M.Sc.

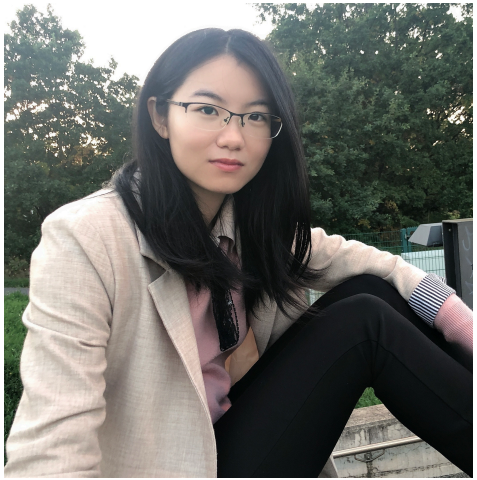
- Research background
  - 2015-2018 Bachelor Degree (Hasso Plattner Institute)
  - 2018-2021 Master Degree (Hasso Plattner Institute)
  - Since 2021 PhD Student at Hasso Plattner Institute
- Research interests
  - Computer vision, document analysis, unsupervised / weakly supervised learning

Personal Information

Gregor Nickel, M.Sc.

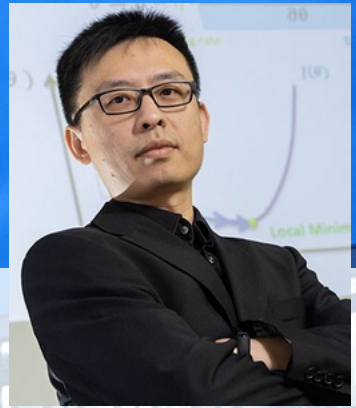
- Research background
  - 2013 – 2018 Bachelor Degree (RWTH Aachen University)
  - 2017 – 2018 Research assistant at the Chair of Imaging and Computer Vision at RWTH Aachen University
  - 2018 – 2020 Master Degree (RWTH Aachen University)
  - 2022 PhD Student at Hasso Plattner Institute
- Research interests
  - Computer vision, optimization of the training process of deep models, efficient deep learning

Personal Information



Ziyun Li, M.sc

- Research background
  - 2013~2017 Bachelor Degree (Hangzhou Dianzi University)
  - 2017~2018 Master Degree (City University of Hongkong)
  - 2019~now PhD Student at Hasso-Plattner-Institute
- Research interests
  - Machine learning, semi-supervised learning, self-supervised learning, transfer learning
  - Novel class discovery, open-set recognition, out-of-distribution, label noise learning



PD Dr. Haojin Yang

- 10/2002-01/2008 media technology (Dipl.-Ing.), University of Technology Ilmenau, Germany
- 11.2013, PhD in Computer Science (CS), Hasso Plattner Institute for Software Systems Engineering (HPI)/University of Potsdam
- 2017-present, head of Multimedia and Machine Learning Research Group, HPI
- since 07/2019, Privatdozent (PD) at HPI/University of Potsdam
  - Habilitation thesis: Deep Representation Learning for Multimedia Data Analysis
- 11/2019-10/2020, Head of Edge Computing Lab Beijing Branch, AI Labs & Video Cloud, Alibaba Group

Current Research Interests

Decoupling the dependence of Deep Learning on high performance computing resources.

- Binary neural networks
- Deep model compression
  - Compact network design using NAS, knowledge distillation, model pruning etc.
- Efficient deep models for large language models
  - Dynamic BERT, binary BERT

Decoupling the dependence of Deep Learning on large-scale labeled datasets.

- Dataset synthesis
  - Text recognition, image analysis in a large-scale Art Historical Database
- Weakly supervised representation learning
- Novel class discovery, noise label

Edge AI

- Future paradigm: computation offloading methods, deep model partitioning, collaborative training and inference etc.

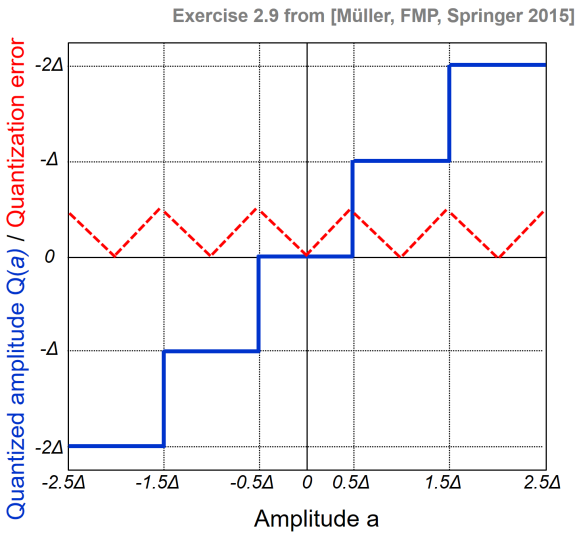
Topic 1: QNN/BNN for Recommender Systems
Motivation

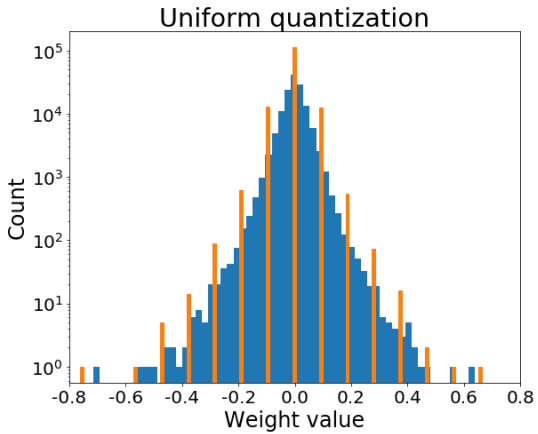
80% of content watched on Netflix, and 60% of videos on YouTube came from recommendations.

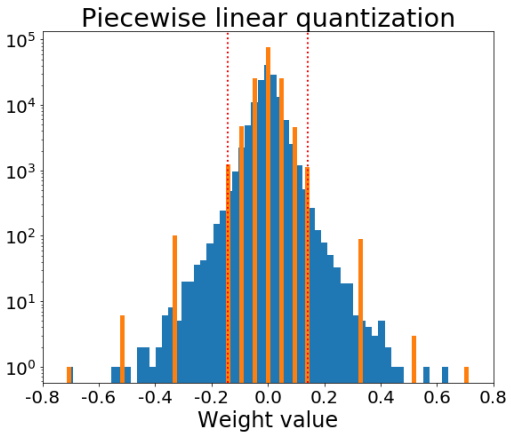
Shuai, Zhang, et a. "Deep Learning based Recommender System: A Survey and New Perspectives." arxiv 2019.

Topic 1: QNN/BNN for Recommender Systems Speed Up

- Quantization/Binarization reduces the runtime/computation needed
- Lower precision operations replace 32-bit floating point operations:
  - INT4 (using 4 bits)
  - Binary (using 1 bit)

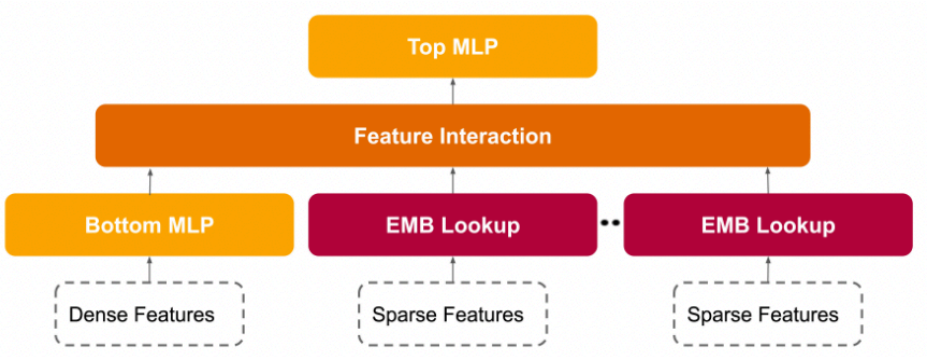






Topic 1: QNN/BNN for Recommender Systems
Previous Work

- Implementation in PyTorch and BITorch (https://github.com/hpi-xnor/bitorch)



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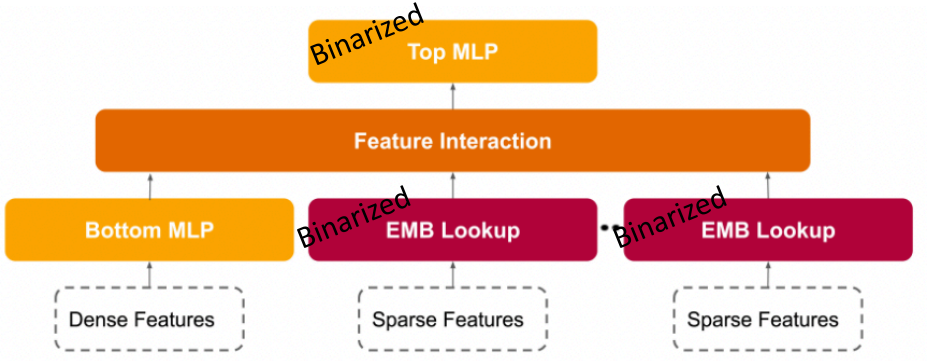

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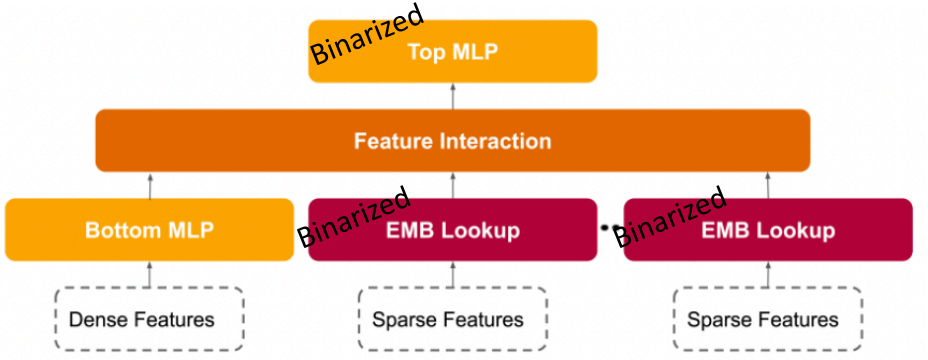


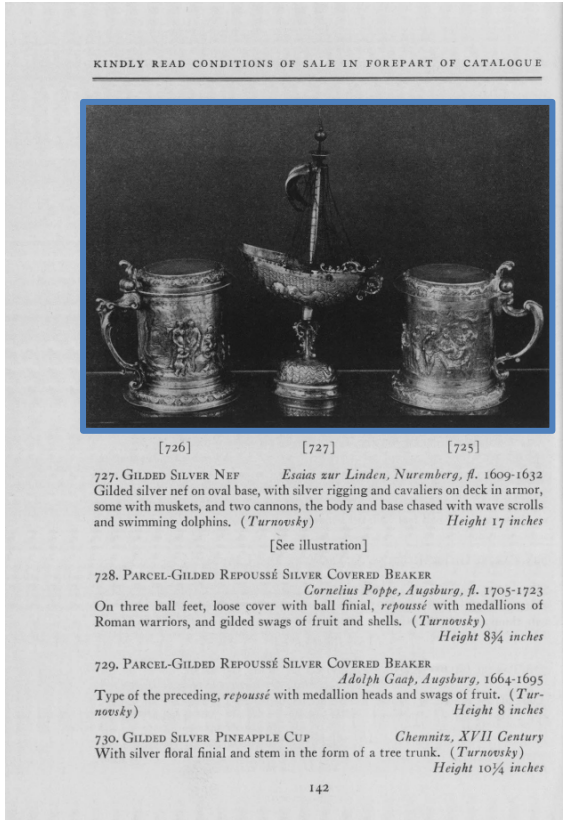
- Results on the *Criteo Display Advertising Challenge* dataset:

Model	ROC AUC	Accuracy	Size (MB)	Speed (MFLOPs)
DLRM Full Precision	0.8021	0.7884	2162	2430
binary DLRM (ours)	0.7839	0.7801	64	974

Topic 1: QNN/BNN for Recommender Systems
Goals

- Understand existing approaches for *recommender systems* based on *(binary) neural networks*
- Improve the model performance by considering quantized (4-bit) layers
- Train and evaluate a quantized/binarized DLRM for larger datasets
- Measure performance gains in practical applications using BITorch

DOCUMENT OBJECT DETECTION



KINDLY READ CONDITIONS OF SALE IN FOREPART OF CATALOGUE

[726] [727] [725]

727. Gilded Silver Nef *Esaias zur Linden, Nuremberg, fl.* 1609-1632
Gilded silver nef on oval base, with silver rigging and cavaliers on deck in armor, some with muskets, and two cannons, the body and base chased with wave scrolls and swimming dolphins. (*Turnovsky*) *Height* 17 *inches*

[See illustration]

728. Parcel-Gilded Repoussé Silver Covered Beaker
Cornelius Poppe, Augsburg, fl. 1705-1723
On three ball feet, loose cover with ball finial, *repoussé* with medallions of Roman warriors, and gilded swags of fruit and shells. (*Turnovsky*)
Height 8¾ *inches*

729. Parcel-Gilded Repoussé Silver Covered Beaker
Adolph Gaap, Augsburg, 1664-1695
Type of the preceding, *repoussé* with medallion heads and swags of fruit. (*Turnovsky*)
Height 8 *inches*

730. Gilded Silver Pineapple Cup *Chemnitz, XVII Century*
With silver floral finial and stem in the form of a tree trunk. (*Turnovsky*)
Height 10¼ *inches*

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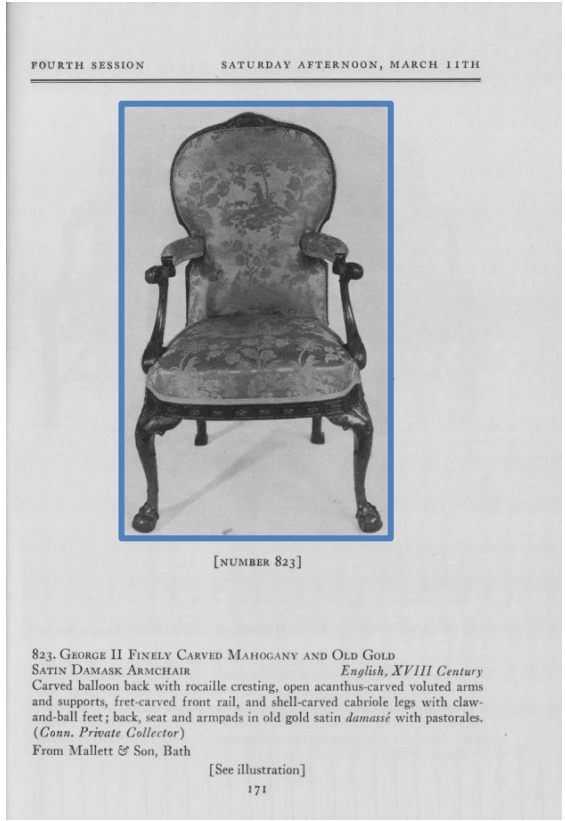

FOURTH SESSION SATURDAY AFTERNOON, MARCH 11TH

[number 823]

823. George II Finely Carved Mahogany and Old Gold Satin Damask Armchair *English, XVIII Century*
Carved balloon back with rocaille cresting, open acanthus-carved voluted arms and supports, fret-carved front rail, and shell-carved cabriole legs with claw-and-ball feet; back, seat and armpads in old gold satin *damassé* with pastorales. (*Conn. Private Collector*)
From Mallett & Son, Bath

[See illustration]

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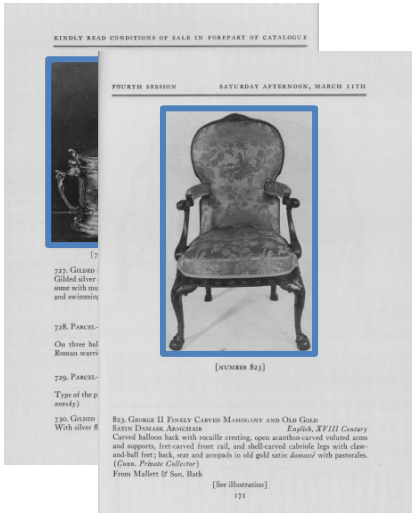
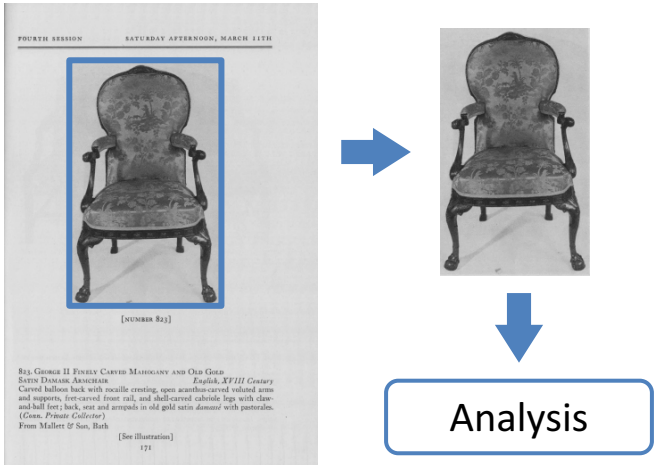
DOD - Motivation

Filter Documents that Contain Certain Objects



Preprocessing for Subsequent Analysis



DOD - Challenge

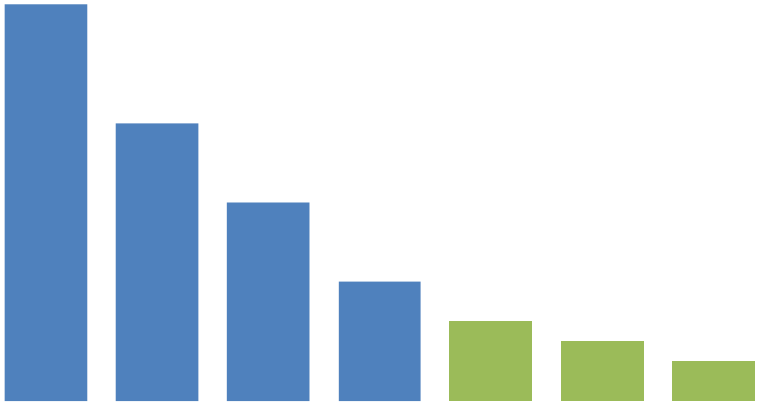
DOD - Solutions

Creation of Synthetic Datasets

Self-Supervision

(Unsupervised) Domain Adaptation

Topic 3: Long-tailed Class Discovery



Topic 3: Long-tailed Class Discovery

Supervised Classification

	Labeled	Unlabeled
Known		
Novel		

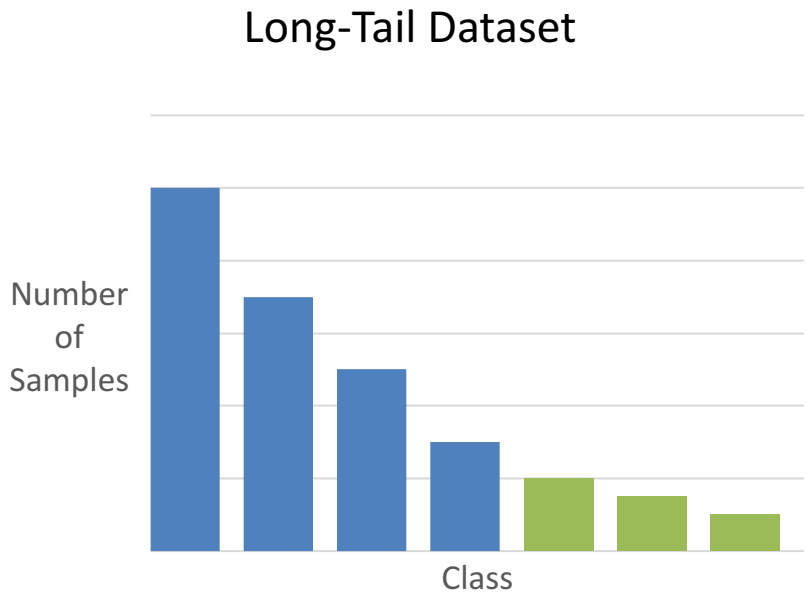
Topic 3: Long-tailed Class Discovery

	Supervised Classification		Novel Class Discovery	
	Labeled	Unlabeled	Labeled	Unlabeled
Known				
Novel				

Topic 3: Long-tailed Class Discovery

	Supervised Classification		Novel Class Discovery		General Class Discovery	
	Labeled	Unlabeled	Labeled	Unlabeled	Labeled	Unlabeled
Known						
Novel						

Topic 3: Long-tailed Class Discovery



Topic 3: Long-tailed Class Discovery

Goals

- Study related work on GCD and long-tail classification
- Decide on approach to tackle GCD on long-tail datasets
- Implement and evaluate approach

Tools and Hardware

- Deep learning framework
  - PyTorch
- GPU servers from Multimedia & Machine Learning group

Grading Policy

- The final evaluation will be based on:
  - Initial implementation / idea presentation, **10%** (A2.1/Zoom, 30.05.2022)
  - Final presentation, **20%** (A2.1/Zoom, 25.07.2022)
  - Report/Documentation, 12-18 pages (single column), **30%** (31.08.2022)
  - Implementation, **40%** (31.08.2022)
  - Participation in the seminar (**bonus**)
  - Grading (30.09.2022)

Enrollment/Anmelden

1. Registration at Studienreferat (Studienreferat(at)hpi.uni-potsdam.de)

- until **29.04.2022**, inform your **preferred and secondary topics** by email
  - Send email to**: haojin.yang@hpi.de**
- **03.05.2022:** Announcement of the topic and group assignment
- After: Individual weekly meeting with teaching team

Contact

Email: {joseph.bethge, ziyun.li, hendrik.raetz, jona.otholt, gregor.nickel, haojin.yang}@hpi.de

Office: H-1.11, H-1.21, H-1.22

Thank you for your Attention!