

STUTTGART MEDIA UNIVERSITY

MASTER THESIS

**Applied Research of an End-to-End
Human Pose-Keypoint Recognition
Network with Figure Ice Skating as
Application Scope**

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for the degree of Master of Science

in the

Research Group Name
Department or School Name

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Declaration of Authorship

I, Nadin-Katrin APEL, declare that this thesis titled, “Applied Research of an End-to-End Human Pose-Keypoint Recognition Network with Figure Ice Skating as Application Scope” and the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.
- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:

Date:

“Thanks to my solid academic training, today I can write hundreds of words on virtually any topic without possessing a shred of information, which is how I got a good job in journalism.”

Dave Barry

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Abstract

Faculty Name

Department or School Name

Master of Science

Applied Research of an End-to-End Human Pose-Keypoint Recognition Network with Figure Ice Skating as Application Scope

by Nadin-Katrin APEL

The Thesis Abstract is written here (and usually kept to just this page). The page is kept centered vertically so can expand into the blank space above the title too...

Acknowledgements

The acknowledgments and the people to thank go here, don't forget to include your project advisor [laser](#)...[laser](#)

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Acronyms

bl layer L with largest feature maps. [xi](#), [5](#)

laser A strange animal, not to be confused with. [ix](#)

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List of Abbreviations

LAH List Abbreviations Here
WSF What (it) Stands For

Physical Constants

Speed of Light $c_0 = 2.997\,924\,58 \times 10^8 \text{ m s}^{-1}$ (exact)

List of Symbols

a	distance	m
P	power	W (J s ⁻¹)
ω	angular frequency	rad

For/Dedicated to/To my...

Chapter 1

Introduction

1.1 Motivation and Goals

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1.2 Related Work

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Chapter 2

Methodology

2.1 Main Section 1

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2.1.1 Subsection 1

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2.1.2 Subsection 2

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2.2 Main Section 2

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Chapter 3

Experiments

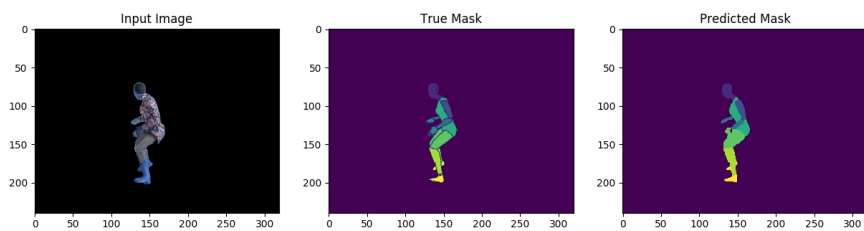


FIGURE 3.1: Predicted mask after 3845. epoch with custom loss function and Adam optimizer

3.1 Different Net Architectures

3.1.1 Extract background

This section will say something about training with background.

- Just extract BG Module with reduced HRNet and then BP recognition
- BP recognition with HRNet (long training/ will this work?)

3.1.2 Recognition of body parts

Stride-down, -up convolution before **bl**

MobileNet extended with UNet

MobileNet extended with HRNet

Experiment with concat and add layers

Best performing network HRNet v7

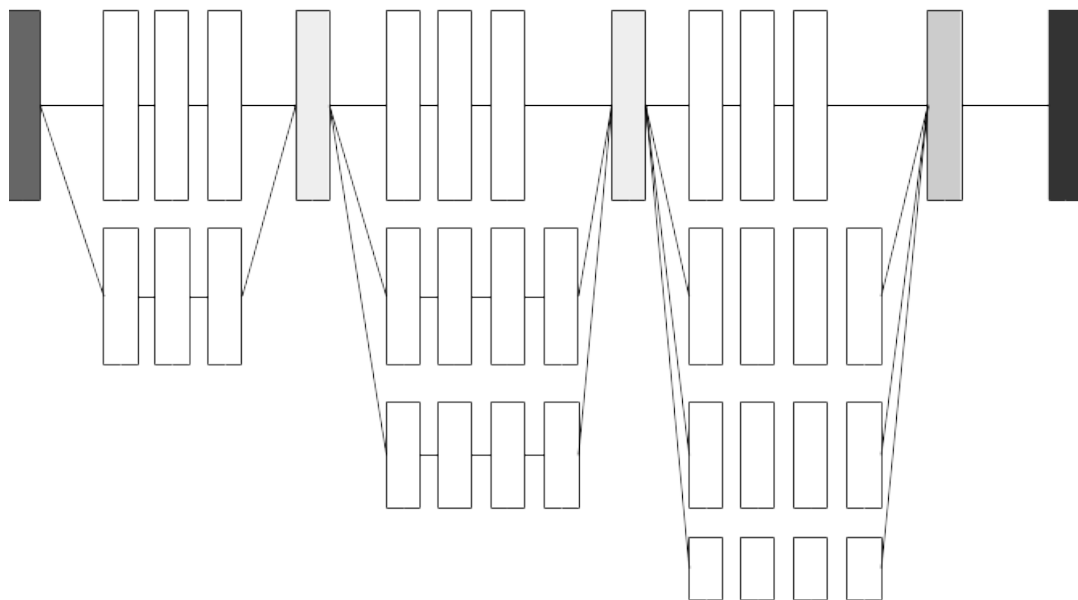


FIGURE 3.2: HRNet v7.

3.2 Comparison of Optimizer Algorithms

- Adam
- Nadam
- SGD

constant learning rate

Constant decreasing learning rate

Constant decreasing learning rate with reset of learning rate on plateau

Increasing decreasing learning rate on plateau

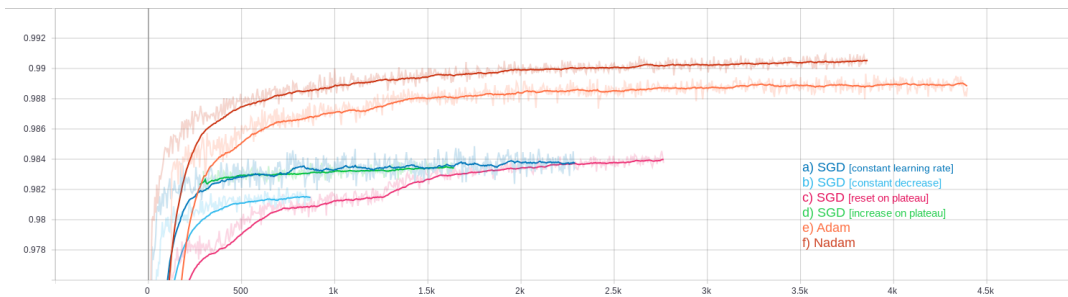


FIGURE 3.3: Accuracy

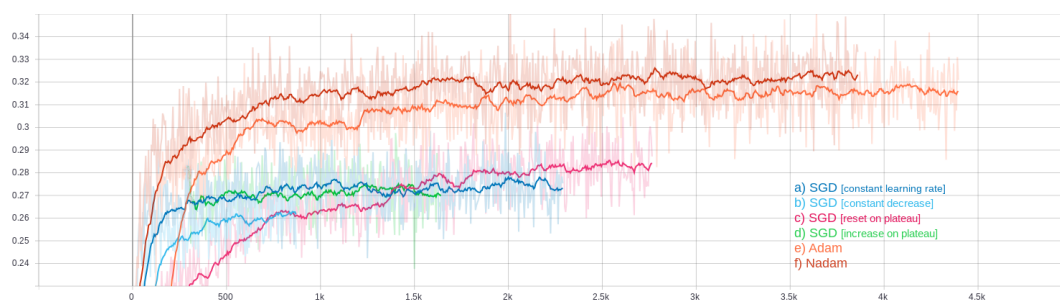


FIGURE 3.4: Correct body part pixel relation

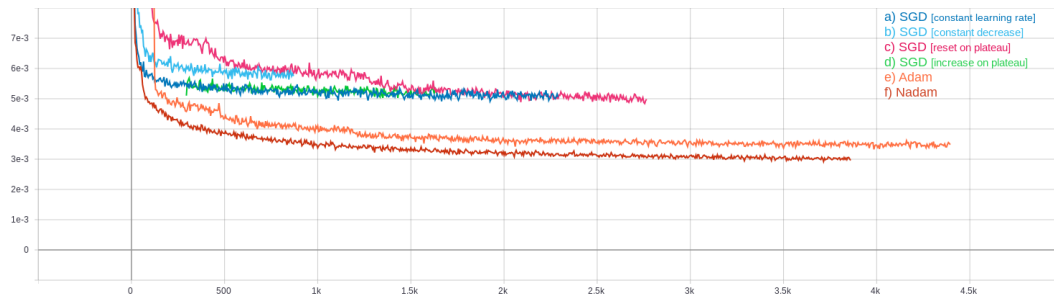


FIGURE 3.5: Loss

Comparison of Adam, Nadam and SGD

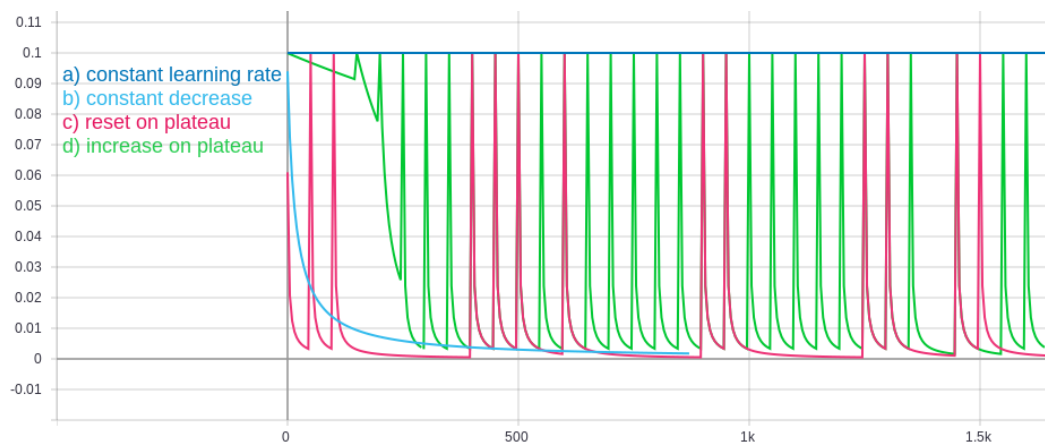


FIGURE 3.6: Learning Rate SGD.

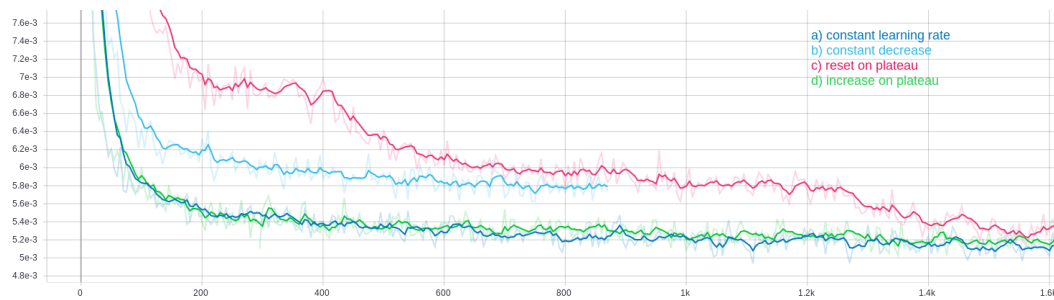


FIGURE 3.7: Loss SGD.

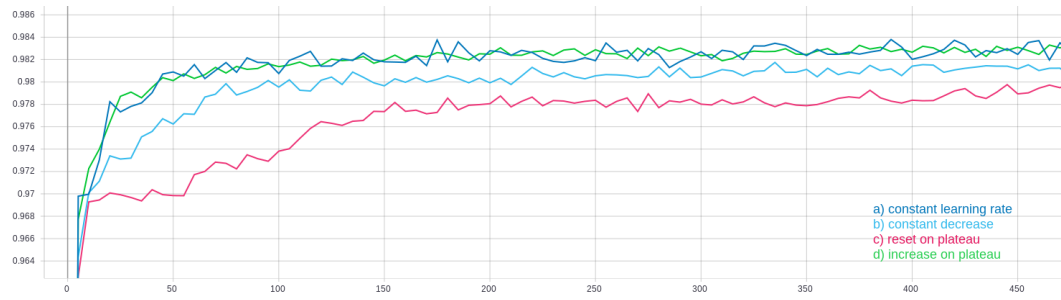


FIGURE 3.8: Accuracy SGD.

Experiments with SGD

3.2.1 Subsection 2

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3.3 Performance of loss functions

All performance measures are conducted on the Nadam optimizer with the HRNet for body part recognition from Recognition of body parts [3.1.2](#)

Sparse Categorical Cross Entropy

Mean Squared Error

Our custom loss function CILoss

This loss function confronts the problem of class imbalance, which especially occurs in body part recognition. The background pixels appear most often, and the different body part classes occur by far less often and event they differentiate a lot in their relative occurrence.

We try to confront this problem with a weighed map, which takes the body parts as a graph and calculates the distances from each body part b_x to all other body parts b_n , and stores this data inside a table.

Additionally this weight map is evened out with a multiplier to reduce the distances and facilitate the learning process for the network.

$$\theta = y_t(x) - y_p(x)$$

$$\delta = \theta * \mu[\operatorname{argmax}(y_t)]$$

$$L = \sum_{i=0}^n \theta_i + \delta_i$$

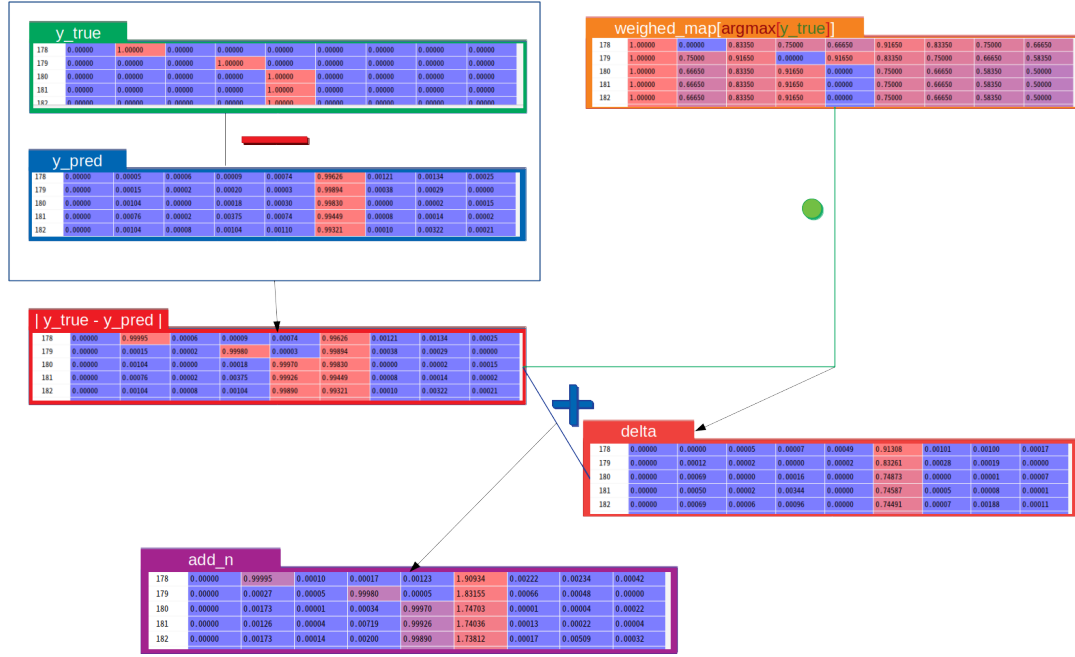


FIGURE 3.9: Visualization of custom loss calculation

3.4 Main Section 2

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Chapter 4

Conclusion and future thoughts

Appendix A

Frequently Asked Questions

A.1 How do I change the colors of links?

The color of links can be changed to your liking using:

```
\hypersetup{urlcolor=red}, or
```

```
\hypersetup{citecolor=green}, or
```

```
\hypersetup{allcolor=blue}.
```

If you want to completely hide the links, you can use:

```
\hypersetup{allcolors=.}, or even better:
```

```
\hypersetup{hidelinks}.
```

If you want to have obvious links in the PDF but not the printed text, use:

```
\hypersetup{colorlinks=false}.
```