Visual assessments of Postural Orientation Errors using ensembles of Deep Neural Networks

LUND UNIVERSITY

LTH

FACULTY OF ENGINEERING

Master's Thesis

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Agenda

1. Introduction
2. Methods
3. Results
4. Conclusions and Future work
5. Titleformats
6. Elements
7. Conclusion

Introduction

Sports injuries

50% of amateur football players in Denmark experience hip/groin pain during season[1].

Around 8000 yearly Anterior cruciate ligament injuries in Sweden[2].

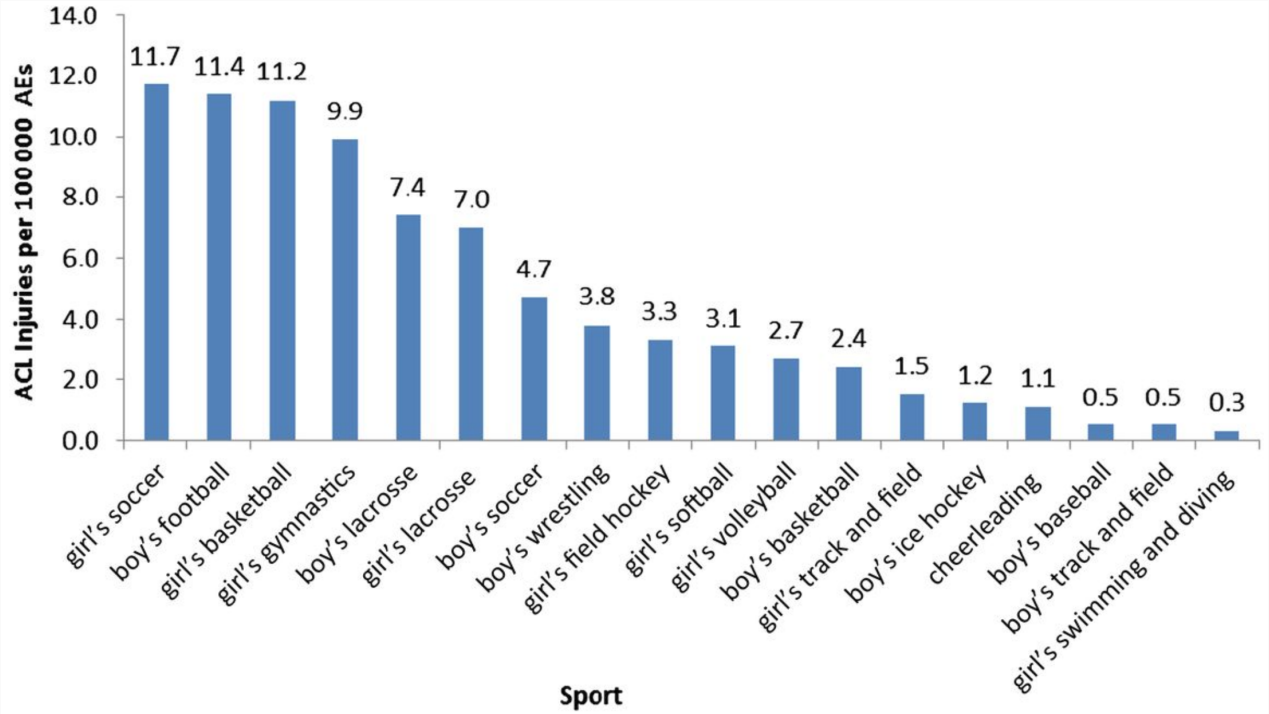


Figure 1: Injury rates among high school students, per 100 000 athlete exposures[3].

[1] Thorborg et al., Prevalence and severity of hip and groin pain in sub-elite male football: a cross-sectional cohort study of 695 players. 2017

[2] Svenska korsbandsregistret, Årsrapport 2019. 2020

[3] LaBella et al., Anterior Cruciate Ligament Injuries: Diagnosis, Treatment, and Prevention. 2014

Anterior cruciate ligament injury and rehabilitation

- Regular injury mechanism is sudden changes in direction or velocity while knee is bearing weight[4].
- Rehabilitation typically up to 2 years[5].
- Increased long and short term risk of, e.g., osteoarthritis[6], joint instability[7], and re-injury[8].

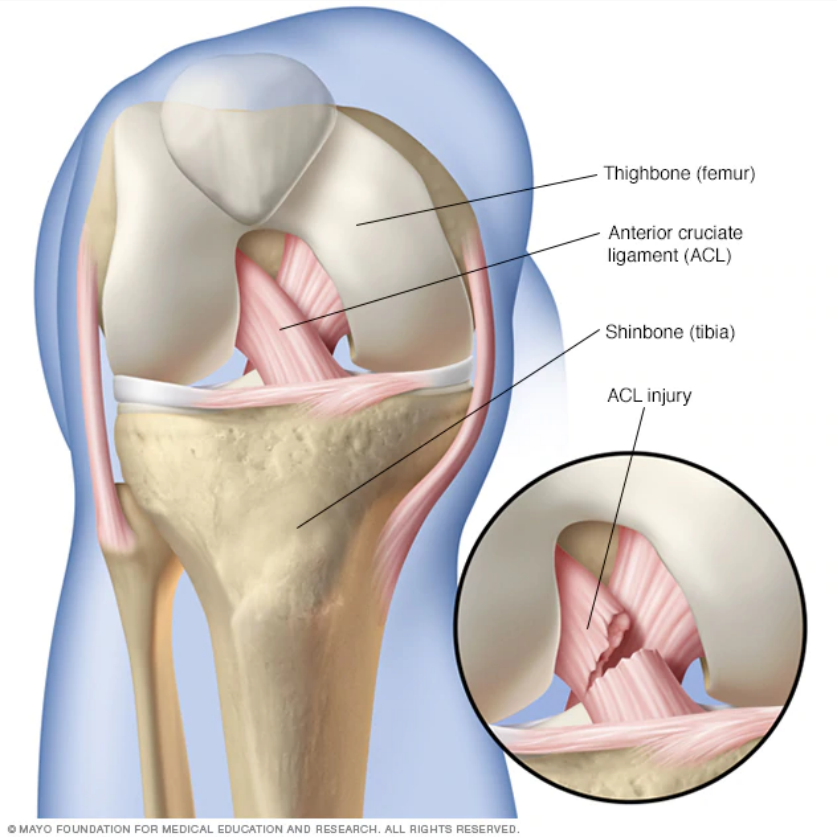


Figure 2: Illustration of ACL in the knee[9].

[4] Wetters et al., Mechanism of Injury and Risk Factors for Anterior Cruciate Ligament Injury. 2016

[5] Nagelli and Hewett, Should Return to Sport be Delayed Until 2 Years After Anterior Cruciate Ligament Reconstruction? Biological and Functional Considerations. 2017

[6] Mayo Clinic, `https://www.mayoclinic.org/diseases-conditions/acl-injury/symptoms-causes/syc-20350738`

[7] Wetters et al., Mechanism of Injury and Risk Factors for Anterior Cruciate Ligament Injury. 2016

[8] Nagelli and Hewett, Should Return to Sport be Delayed Until 2 Years After Anterior Cruciate Ligament Reconstruction? Biological and Functional Considerations. 2017

[9] Mayo Clinic, `https://www.mayoclinic.org/diseases-conditions/acl-injury/symptoms-causes/syc-20350738`

Postural Orientation Errors

Figure 3: Examples of maintained (left) and altered postural orientation (right) during a single leg squat.

- Ability to uphold alignment of body parts.
- Altered PO - seen to increase risk of re-injury.
- No established and feasible method to assess for clinical use.
- Proposed methods where experts assess motions on videos - time consuming[10].

[10] Nae et al., Extended Version of a Test Battery for Visual Assessment of Postural Orientation Errors: Face Validity, Internal Consistency, and Reliability. 2020

ngt om avgransningar och de olika poesen

wtf?

Methods

System overview

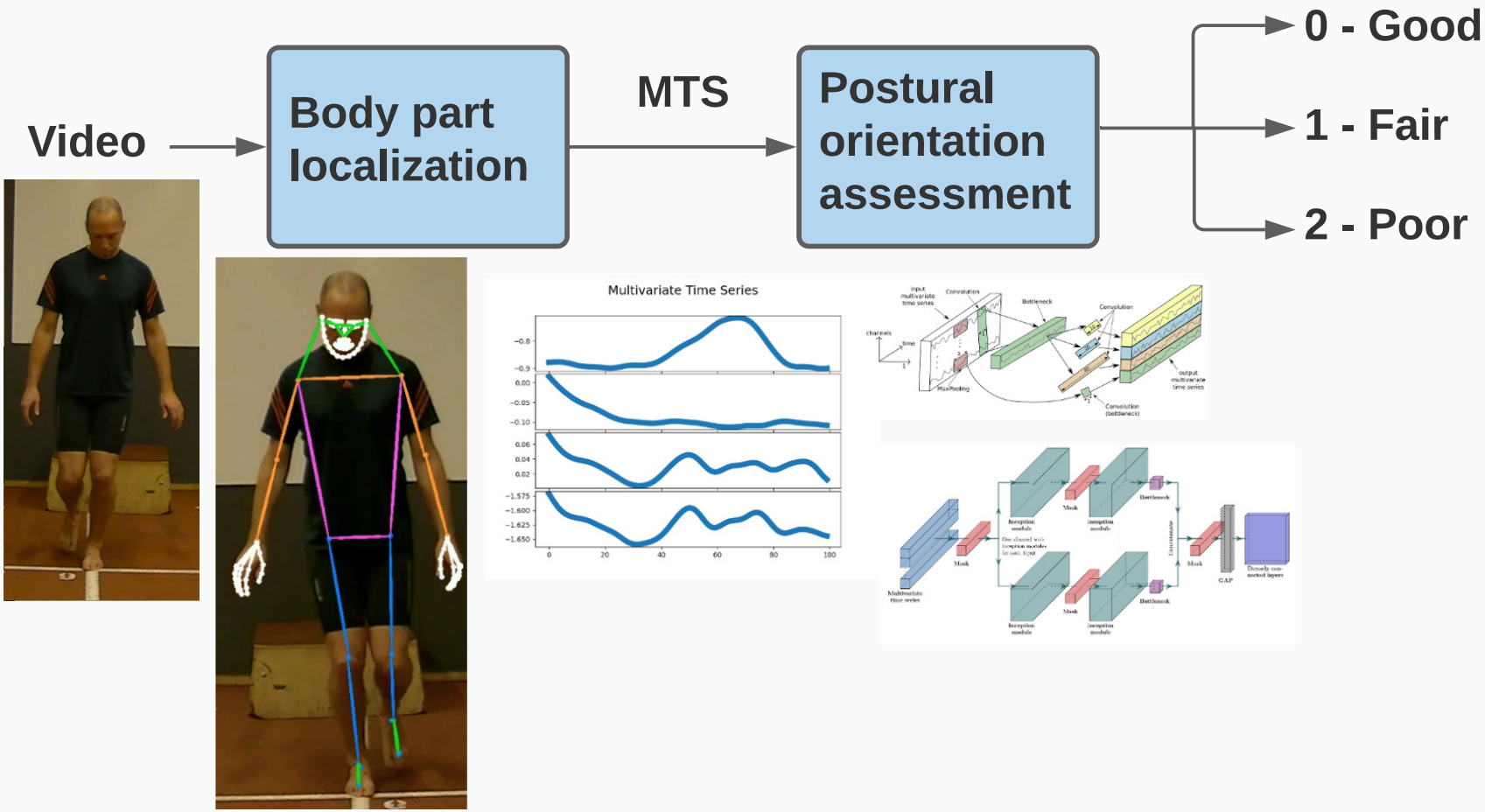


Figure 4

Body part localization

- Built upon MMPose framework[11].
- HRNet[12]with DARK-pose[13]trained on COCO-wholebody dataset used for pose estimation.
- Outputs 133 keypoint coordinates.

[11]MMPose - OpenMMLab, `https://github.com/open-mmlab/mmpose`

[12]Sun et al., Deep high-resolution representation learning for human pose estimation. 2019

[13]Zhang et al., Distribution-Aware Coordinate Representation for Human Pose Estimation. 2020

Time series classification - Network architectures

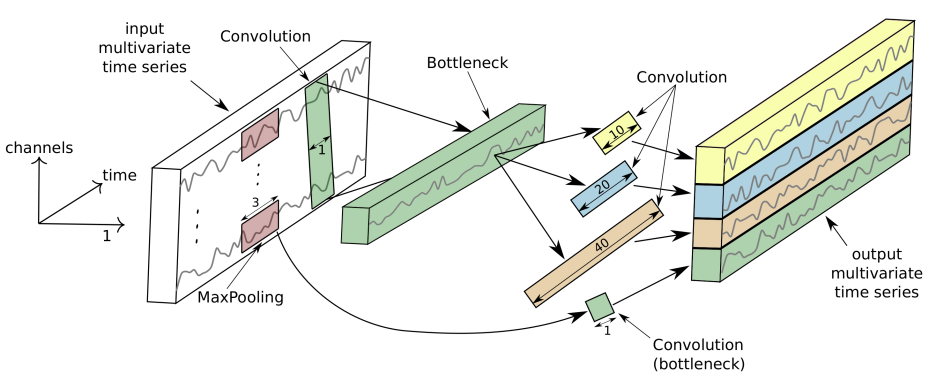


Figure 5: InceptionTime module.

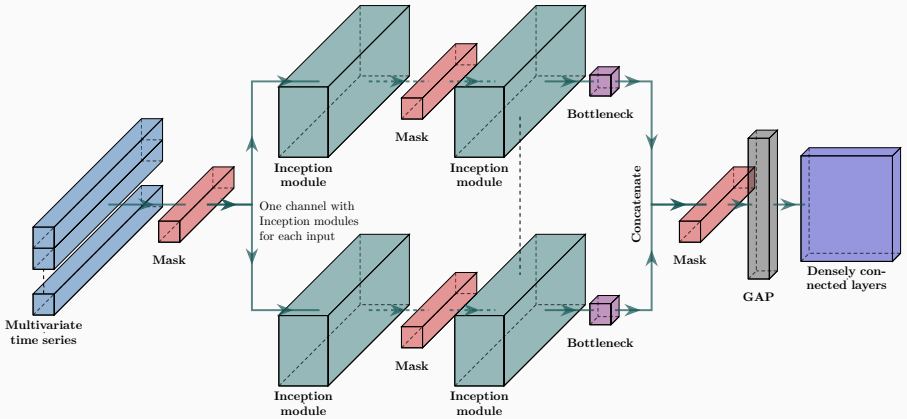


Figure 6: X-InceptionTime.

IncetionTime[14]

Modules with convolutions of different lengths, global average pooling, and densely connected layers for classification.

X-IncetionTime

Like InceptionTime, but input channels are kept separate.

[14] Fawaz et al., nceptionTime: Finding AlexNet for time series classification. 2020

Time series classification - Ensembles

prata om fem modeller/poe. 2 almanna, med coral ordinal (presentera denna lite), och tre high precision models (presentera den loss function??)

ngt mer ??

Results

Data

beskriv datan, typ video/reps, Antal, training/test split. Cross-val

Conclusions and Future work

Metropolis

The **METROPOLIS** theme is a Beamer theme with minimal visual noise inspired by the HSRM Beamer Theme by Benjamin Weiss.

Enable the theme by loading

```
\documentclass{beamer}
\usetheme{metropolis}
```

Note, that you have to have Mozilla's *Fira Sans* font and XeTeX installed to enjoy this wonderful typography.

Sections

Sections group slides of the same topic

```
\section{Elements}
```

for which **METROPOLIS** provides a nice progress indicator ...

Titleformats

Metropolis titleformats

METROPOLIS supports 4 different titleformats:

- Regular
- SMALLCAPS
- ALLSMALLCAPS
- ALLCAPS

They can either be set at once for every title type or individually.

Small caps

This frame uses the `smallcaps` titleformat.

Potential Problems

Be aware, that not every font supports small caps. If for example you typeset your presentation with pdfTeX and the Computer Modern Sans Serif font, every text in smallcaps will be typeset with the Computer Modern Serif font instead.

ALL SMALL CAPS

This frame uses the `allsmallcaps` titleformat.

Potential problems

As this titleformat also uses smallcaps you face the same problems as with the `smallcaps` titleformat. Additionally this format can cause some other problems. Please refer to the documentation if you consider using it.

As a rule of thumb: Just use it for plaintext-only titles.

ALL CAPS

This frame uses the `allcaps` titleformat.

Potential Problems

This titleformat is not as problematic as the `allsmallcaps` format, but basically suffers from the same deficiencies. So please have a look at the documentation if you want to use it.

Elements

Typography

```
The theme provides sensible defaults to
\emph{emphasize} text, \alert{accent} parts
or show \textbf{bold} results.
```

becomes

The theme provides sensible defaults to *emphasize* text, accent parts or show **bold** results.

Font feature test

- Regular
- *Italic*
- SmallCaps
- **Bold**
- ***Bold Italic***
- **Bold SmallCaps**
- `Monospace`
- `Monospace Italic`
- **`Monospace Bold`**
- `Monospace Bold Italic`

Lists

Items

- Milk
- Eggs
- Potatos

Enumerations

1. First,
2. Second and
3. Last.

Descriptions

PowerPoint Meeh.

Beamer Yeeeha.

Animation

- This is important

Animation

- This is important
- Now this

Animation

- This is important
- Now this
- And now this

Animation

- This is really important
- Now this
- And now this

Figures

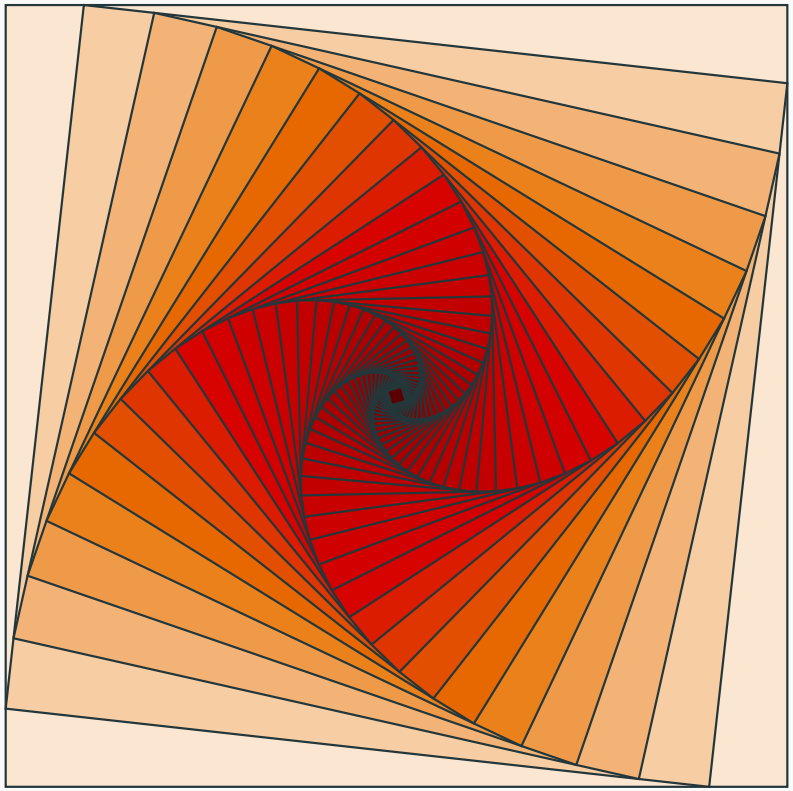


Figure 1: Rotated square from texample.net.

Tables

Table 1: Largest cities in the world (source: Wikipedia)

City	Population
Mexico City	20,116,842
Shanghai	19,210,000
Peking	15,796,450
Istanbul	14,160,467

Blocks

Three different block environments are pre-defined and may be styled with an optional background color.

Default
Block content.

Alert
Block content.

Example
Block content.

Default

Block content.

Alert

Block content.

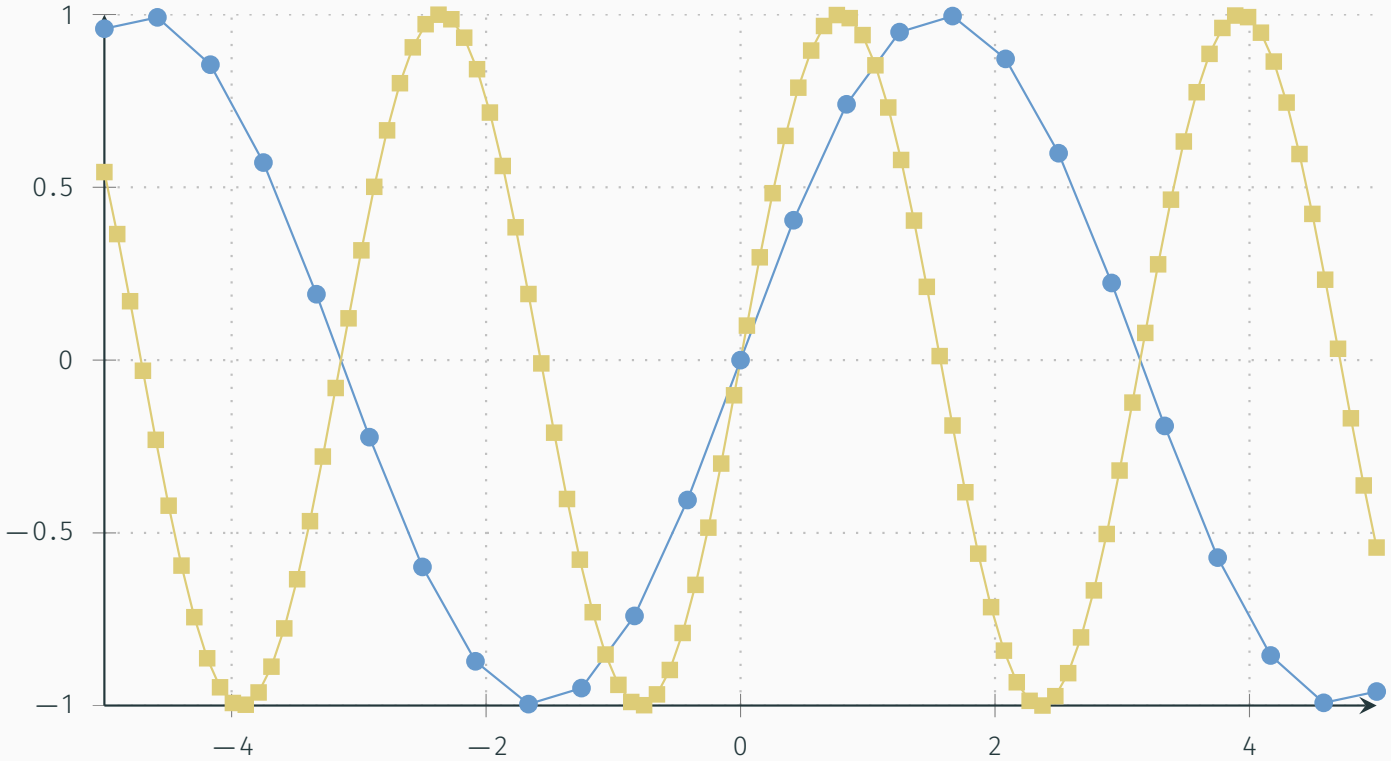
Example

Block content.

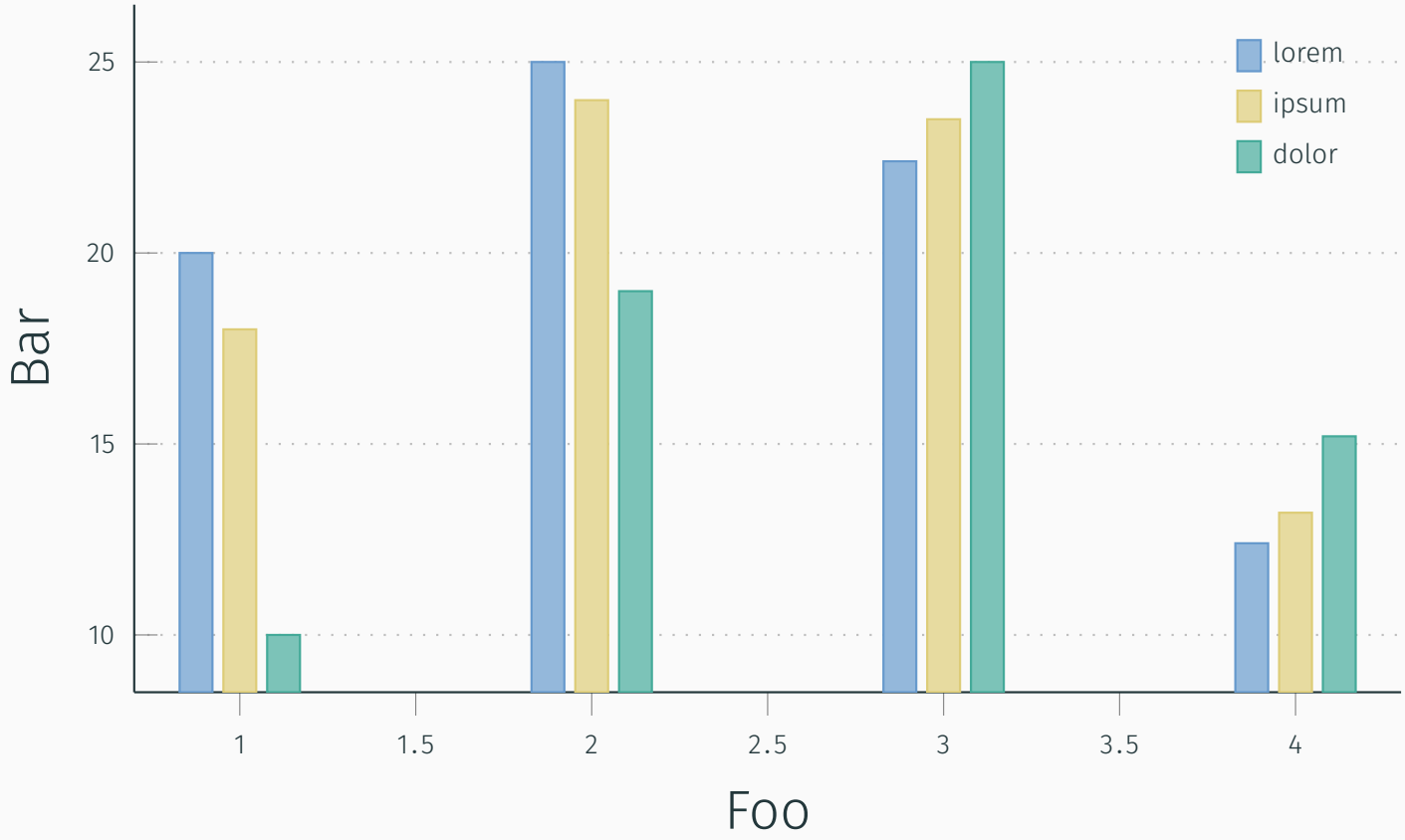
Math

$$e = \lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n$$

Line plots



Bar charts



Quotes

Veni, Vidi, Vici

Frame footer

METROPOLIS defines a custom beamer template to add a text to the footer. It can be set via

```
\setbeamertemplate{frame footer}{My custom footer}
```

Conclusion

Summary

Get the source of this theme and the demo presentation from

`github.com/matze/mtheme`

The theme *itself* is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

Questions?

Backup slides

Sometimes, it is useful to add slides at the end of your presentation to refer to during audience questions.

The best way to do this is to include the `appendixnumberbeamer` package in your preamble and call `\appendix` before your backup slides.

METROPOLIS will automatically turn off slide numbering and progress bars for slides in the appendix.

References i