43075-01 Shape modelling and analysis

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Exercise sheet 6: Building a GP Model

Introduction: 11. April 2023

Project deadline: 24. April 2023

Introduction

You have already built a Gaussian process model, which models your prior beliefs about the variability of femur shapes. However, this model is rather crude and does not make use that we have over 40 example femur shapes available. The goal of this exercise is to use this model to fit the shape of all the example femur bones, and use these fitted shapes to estimate the real shape variability of a femur bone.

1 Fitting the example femur bones

Work through tutorial 11 of the Scalismo tutorials (https://scalismo.org/docs/tutorials/tutorial11) and use it as a basis to develop your own fitting method:

- Fit the model to each example femur. Save the result.
- Visualize the data. Do the registered surfaces look like the target surface? Is the mesh still regular or does it fold (press `W` in ScalismoUi to see a wireframe representation. Press `S` to switch back).
- It might happen that for some bones the model does not fit well as it will end up in a local minimum. You can try different strategies to improve the situation.
  - You might think of a strategy to incorporate the landmarks.
  - You can try to do a coarse fit first (using only the first principle components) and use the full model in a second step.
  - A model can be reduced by calling the `truncate` method on a model. For example, use `pdm.truncate(10)` to reduce the model to the first 10 basis functions.

2 Building a statistical shape model

Follow tutorial 6 of the Scalismo tutorials (https://scalismo.org/docs/tutorials/tutorial06) and use the steps discussed there to learn a shape model from the data.
Use the fitted meshes from the previous exercise to build a model.

3 Validate and improve the model

Validate the model using suitable visualizations, predictive checks and cross-validation. You can find inspiration in the lecture slides and the Bayesian workflow paper:

- Lecture Slides: https://adam.unibas.ch/goto_adam_file_1586026_download.html
- Bayesian workflow: https://arxiv.org/pdf/2011.01808.pdf

4 Write the report

Write the project report. Follow the instructions given in the project guideline

- https://adam.unibas.ch/goto_adam_file_1568842_download.html

5 Theory

Work through the theory parts of week 7 and skim through the material of week 8.

- https://shapemodelling.cs.unibas.ch/ssm-course/week7/

- https://shapemodelling.cs.unibas.ch/ssm-course/week8/

You can add questions and topics that you would like to discuss in class to the Etherpad on Adam:

- https://adam.unibas.ch/goto_adam_xpdl_1553025.html