

# 43075-01 Probabilistic Shape Modelling

## Project 2

Introduction 21.04.  
Deadline **25.05, 23:55 (on Adam)**

### Introduction

The goal in this project is to perform a model-based segmentation of 5 CT liver images using model fitting. The goal is to derive a fitting procedure, which approximates a given ground-truth segmentation as accurately as possible. You are free to include user annotation, such as corresponding landmarks or contour points marked on the target image, into your solution.

The project is organized in two steps:

**Step 1** Fit a model to user-defined landmarks (Exercise 3)

**Step 2** Adapt the fitting method to use intensity information, by e.g. including the given Active Shape model in some way.

## 1 Software and project data

You can download a zip file with the project and the data on adam. The zip file contains the following datasets:

- An Active Shape Model of the liver learned from 20 registered livers
- A validation set consisting of 5 images with a corresponding ground-truth segmentation as well as user annotations.
- A test set of 5 images which need to be fitted
- An example Scalismo project, which you can use to get started.

*Note: There are no landmarks given for the test data. This does not mean that you are not supposed to use landmarks or other annotations, but only that you will have to annotate the data by yourself. In case you find it difficult to locate the correct landmark position in the images, make sure that this is reflected in the uncertainty.*

### Project Task

The project is divided into two steps:

1. Initial alignment and coarse initialization of the pose using user landmarks and other user annotation. These task is detailed in Exercise sheet 3. You may use any type of user annotation you find helpful.
2. Detailed segmentation of the liver. In this step, intensity information and any other information that you think could improve the segmentation can be included. Read the tutorial on Active Shape Model (Tutorial 14 on scalismo.org) and think about how you could include it into the project.



## 2 Including an Active Shape Model

In case you include an Active Shape Model in your fitting, it may happen that sometimes a feature point is outside the image domain. If this happens, you will get an exception when you use directly the code from the tutorial. You can handle this case by pattern matching on the result of the `featureExtractor` as follows:

```
asm.featureExtractor(preprocessedImage, pointToTest, mesh, profile.pointId) match {  
  case Some(p) => profile.distribution.logpdf(p)  
  case None => 1e-5 // not a good solution - penalized (must not be -Infinity)  
}
```

## 3 Validating your method

The class `validate.Validation` provides a validation script which validates the quality of your fitting on the validation set. Place your results in the corresponding folder and run script.

## 4 Hints

- The sample and parameter class, which you can find in the folder `src/main/scala/liverfitting` can be written to disk and read using the methods `read` and `write`. This can be useful to rerun a chain from a particular state, in order to save computation time.
- Think carefully about how to choose the parameters, in particular the uncertainties. Remember that the unit of measure is mm.
- Visualize and plot intermediate results. This helps you to see where the sampler does not behave like you would have expected.
- Ask for help in the forum or during the exercise sessions and start early enough.

## Submission

To submit your solution, please add your fitting to the corresponding folder `testset/fitting` and zip the full project. Don't forget to add your report. Upload the zip file to Adam.

## 5 Grading

Our main source for grading your work will be the report. The report should be 3-5 pages long. Please make sure that it is well written and clearly explains the methods you used and your choices of parameters. Also include a discussion of your results.

We will grade the report according to the following criteria:

- Structure of the report, Clarity of exposition (20 %)
  - How easy is it to understand what you did?
- Theoretical correctness (30 %)
  - Does your report show an understanding of the concepts.
- Originality / Own thoughts and ideas (25 %)
  - Does your method include ideas that go beyond the “recipe’s” given in the tutorials
- Quality of the results (25 %)
  - How well did your method reconstruct the given target surfaces.

