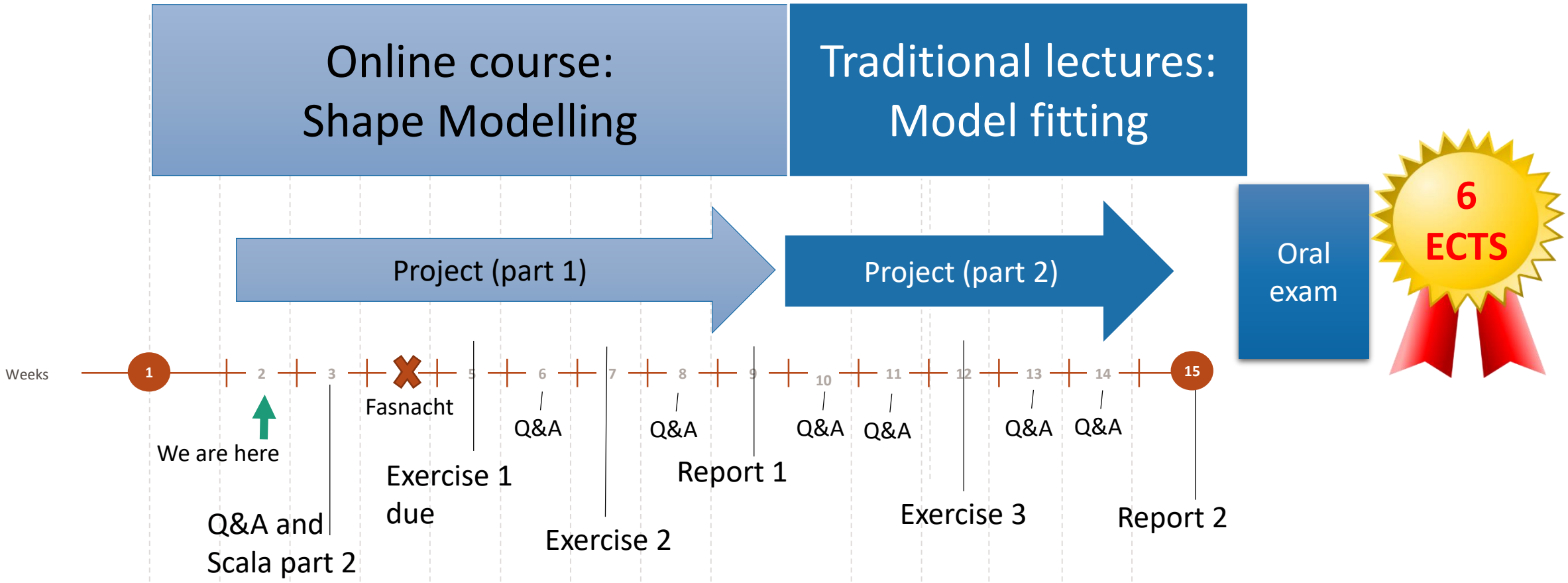
Probabilistic Shape Modelling: Projects and exercises

Ghazi Bouabene

Outline

- Project modalities
  - Expected deliverables
- Exercises modalities
- Overview of Exercise 1
- Q&A first week & IDE installation

How to get the credit points



- Exercises (ideally in groups of 2) need to be presented in exercise sessions

Projects

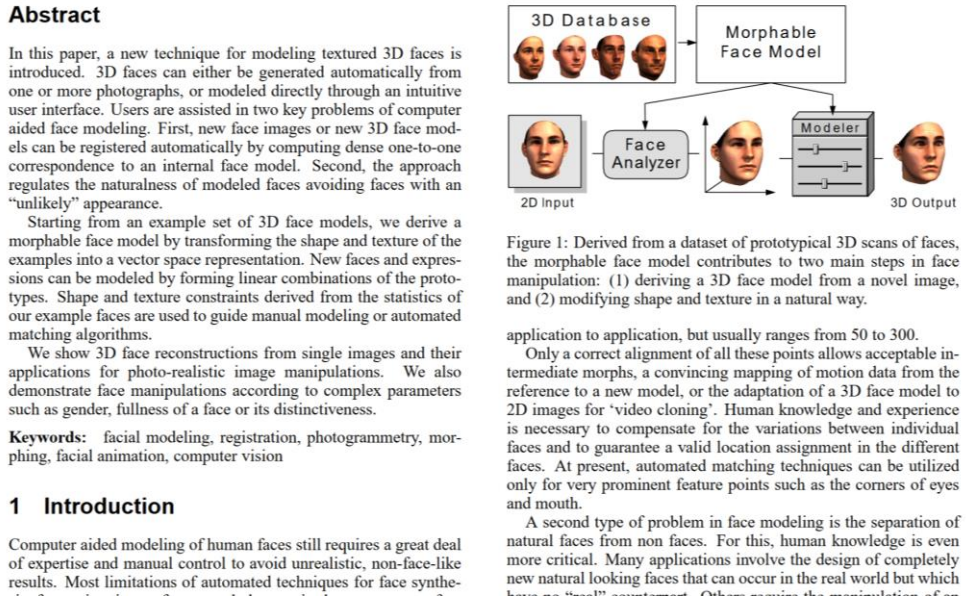
- 2 projects:
  - First is the FutureLearn one: reconstruct missing parts of a bone dataset
  - Second project: Femur segmentation from a CT image

- Both projects are graded and **mandatory**! 25% of final grade

- For both, you need to deliver the following:
  - Data resulting from your work (e.g. bone reconstructions for project 1)
  - Code of your solution
  - A report detailing your solution

Reports

- A mini scientific paper
- Structure:
  - Short introduction (What you solve)
  - Method (How you solve it)
  - Results (What results did you achieve?)
  - Discussion
    - What can you say about the results
    - Why are the results like that
    - How could you improve the method/results



Abstract

In this paper, a new technique for modeling textured 3D faces is introduced. 3D faces can either be generated automatically from one or more photographs, or modeled directly through an intuitive user interface. Users are assisted in two key problems of computer aided face modeling. First, new face images or new 3D face models can be registered automatically by computing dense one-to-one correspondence to an internal face model. Second, the approach regulates the naturalness of modeled faces avoiding faces with an "unlikely" appearance.

Starting from an example set of 3D face models, we derive a morphable face model by transforming the shape and texture of the examples into a vector space representation. New faces and expressions can be modeled by forming linear combinations of the prototypes. Shape and texture constraints derived from the statistics of our example faces are used to guide manual modeling or automated matching algorithms.

We show 3D face reconstructions from single images and their applications for photo-realistic image manipulations. We also demonstrate face manipulations according to complex parameters such as gender, fullness of a face or its distinctiveness.

Keywords: facial modeling, registration, photogrammetry, morphing, facial animation, computer vision

1 Introduction

Computer aided modeling of human faces still requires a great deal of expertise and manual control to avoid unrealistic, non-face-like results. Most limitations of automated techniques for face synthe-

Figure 1: Derived from a dataset of prototypical 3D scans of faces, the morphable face model contributes to two main steps in face manipulation: (1) deriving a 3D face model from a novel image, and (2) modifying shape and texture in a natural way.

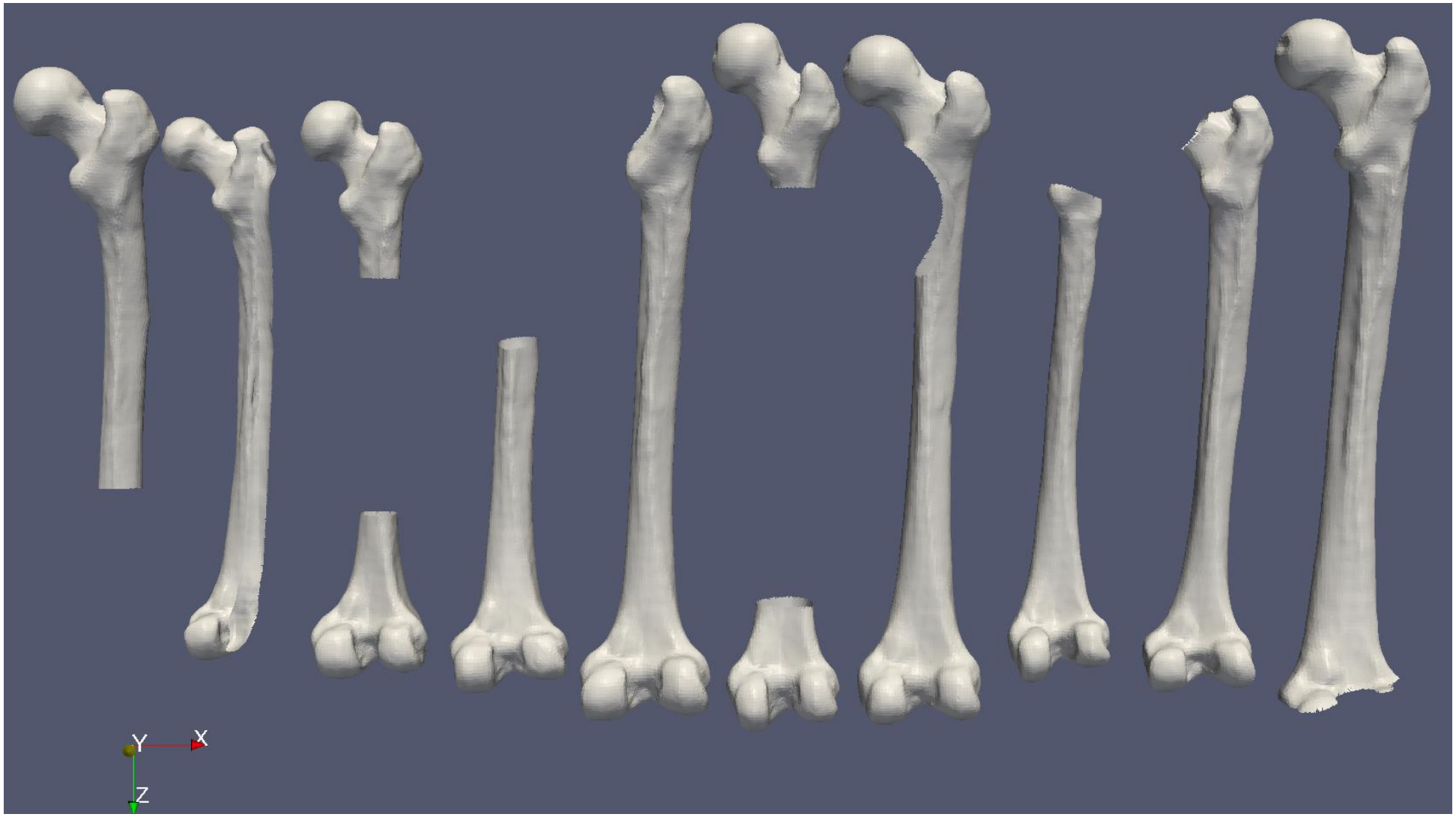
application to application, but usually ranges from 50 to 300.

Only a correct alignment of all these points allows acceptable intermediate morphs, a convincing mapping of motion data from the reference to a new model, or the adaptation of a 3D face model to 2D images for 'video cloning'. Human knowledge and experience is necessary to compensate for the variations between individual faces and to guarantee a valid location assignment in the different faces. At present, automated matching techniques can be utilized only for very prominent feature points such as the corners of eyes and mouth.

A second type of problem in face modeling is the separation of natural faces from non faces. For this, human knowledge is even more critical. Many applications involve the design of completely new natural looking faces that can occur in the real world but which

- Let us know what you did / understood and what you learned

First project: reconstruct partial femurs



First project: reconstruct partial femurs

- Different steps involved:
  - Prepare the data for shape analysis : Rigid alignment
  - Build a “free-form” deformation model using Gaussian Processes
  - Use the model to register the aligned dataset and learn a PCA model
  - Use the PCA model for shape completion with GP regression
- All the steps broken down as parts of the Exercises
  - e.g Rigid alignment is part of Exercise 1
- **Break your code also into steps and save your results to files**

Online evaluation system

- Once you have your reconstructions, you can upload them to an online platform
  - Compete against submissions from other FL learners

Evaluation Results

Search:

		Average Distance											Hausdorff Distance										
Position	User	average	1	2	3	4	5	6	7	8	9	10	average	1	2	3	4	5	6	7	8	9	10
1 (2.20)	wislo1	1.85 (1.9)	2.06 (1)	1.58 (1)	1.66 (3)	1.65 (5)	2.29 (1)	1.72 (1)	1.33 (2)	2.73 (3)	1.37 (1)	2.11 (1)	6.47 (2.5)	5.81 (2)	7.30 (5)	5.35 (3)	8.83 (5)	8.28 (1)	5.41 (1)	6.65 (2)	8.25 (4)	3.00 (1)	5.82 (1)
2 (3.25)	dehal1	2.33 (3.5)	2.96 (6)	2.17 (4)	1.63 (2)	1.54 (4)	4.06 (7)	2.19 (2)	1.21 (1)	2.57 (2)	2.49 (4)	2.51 (3)	7.48 (3)	8.90 (5)	6.57 (1)	4.98 (2)	4.15 (1)	18.22 (9)	6.82 (2)	2.91 (1)	7.85 (2)	6.33 (4)	8.11 (3)
3 (4.30)	budep1	2.40 (4)	2.42 (3)	2.32 (5)	1.69 (4)	1.50 (3)	2.82 (3)	3.87 (7)	1.73 (3)	3.04 (5)	2.04 (3)	2.58 (4)	10.17 (4.6)	6.65 (3)	8.78 (7)	6.45 (4)	8.23 (3)	14.27 (6)	19.95 (7)	7.40 (3)	8.35 (5)	5.90 (3)	15.73 (5)
4 (4.40)	probt1	3.05 (4.7)	2.13 (2)	2.47 (6)	4.38 (9)	1.41 (1)	3.70 (6)	6.35 (9)	4.11 (9)	1.79 (1)	1.93 (2)	2.27 (2)	12.08 (4.1)	4.18 (1)	6.66 (2)	25.02 (9)	7.94 (2)	14.26 (5)	23.69 (8)	21.58 (9)	5.88 (1)	4.07 (2)	7.55 (2)
5 (5.40)	ozdef1	2.98 (5.3)	3.57 (7)	1.80 (2)	2.05 (5)	1.47 (2)	3.69 (5)	3.06 (3)	2.28 (7)	5.20 (9)	3.41 (7)	3.31 (6)	10.94 (5.5)	9.28 (6)	7.41 (6)	7.10 (5)	10.31 (7)	12.59 (3)	16.50 (4)	11.36 (7)	13.96 (8)	6.92 (5)	13.93 (4)
6 (6.15)	sharv1	3.43 (6.4)	4.37 (9)	2.96 (7)	3.35 (7)	3.23 (7)	2.76 (2)	3.36 (4)	2.93 (8)	3.12 (6)	3.16 (6)	5.06 (8)	12.34 (5.9)	13.79 (9)	7.18 (4)	13.22 (7)	8.49 (4)	10.23 (2)	19.37 (6)	9.49 (5)	10.42 (7)	7.85 (7)	23.33 (8)
7 (6.25)	lobor1	15.35 (6.7)	2.70 (4)	4.60 (9)	1.58 (1)	3.40 (9)	5.45 (9)	4.32 (8)	2.18 (6)	3.17 (7)	123.11 (9)	3.02 (5)	30.30 (5.8)	7.78 (4)	20.11 (9)	4.91 (1)	12.75 (9)	17.59 (7)	15.93 (3)	9.19 (4)	10.15 (6)	187.00 (9)	17.61 (6)
8 (6.35)	madsd1	3.59 (6.5)	3.81 (8)	4.45 (8)	3.90 (8)	3.35 (8)	5.03 (8)	3.49 (5)	2.12 (4)	2.88 (4)	2.70 (5)	4.24 (7)	12.88 (6.2)	9.30 (7)	16.89 (8)	12.13 (6)	9.21 (6)	17.61 (8)	17.74 (5)	10.48 (6)	8.19 (3)	7.16 (6)	20.06 (7)
9 (6.70)	thria1	4.61 (6)	2.89 (5)	2.04 (3)	2.81 (6)	2.18 (6)	3.38 (4)	3.52 (6)	2.18 (5)	3.90 (8)	4.05 (8)	19.17 (9)	16.72 (7.4)	10.34 (8)	6.92 (3)	14.20 (8)	11.50 (8)	13.36 (4)	26.12 (9)	12.17 (8)	15.36 (9)	8.00 (8)	49.22 (9)

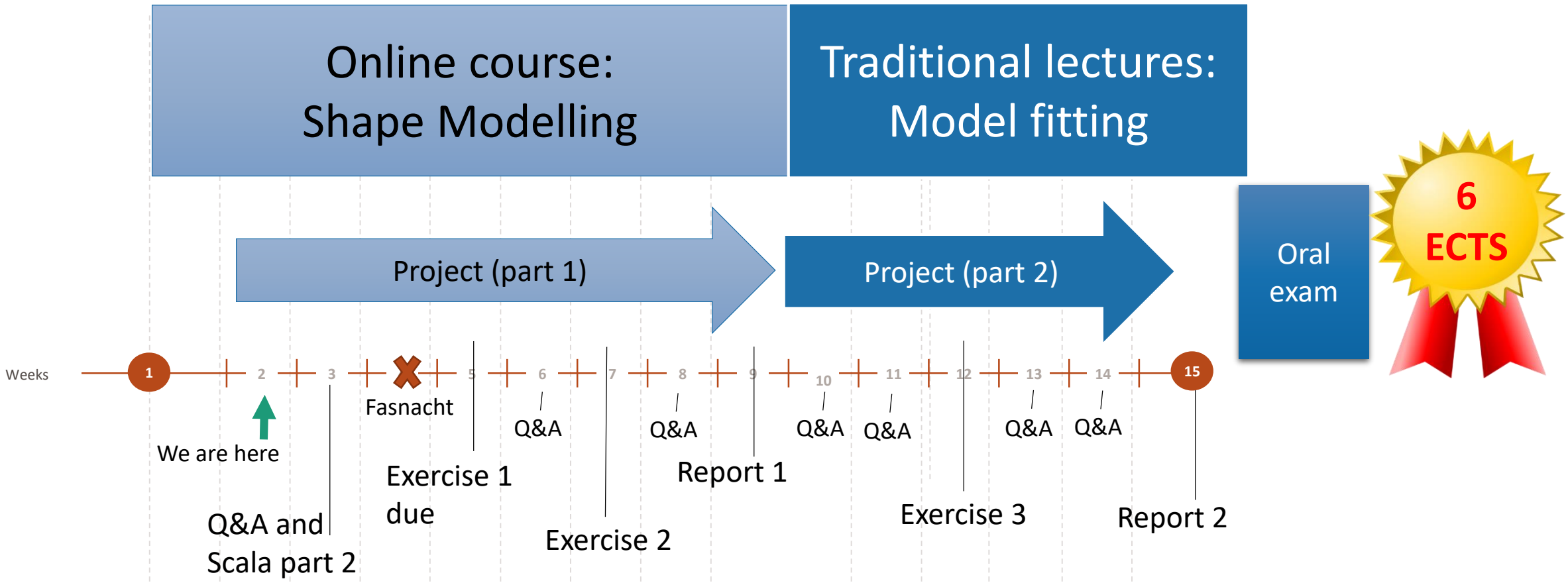
Exercises

- 3 Exercises in total
- Here to keep you on track with the online learning
  - Theory check-up
  - Steps towards implementing the project
- Presence not mandatory: except for the result presentation
  - bring your laptop and code!
- Exercise grading: Not graded, but **mandatory**.
- Groups of 1 or 2: **please form groups and inform us latest by March 5th such that we can assign you timeslots**

Exercise 1

Already online. Hand in / discussion date 19th March

Timeline


Online course:
Shape Modelling
Traditional lectures:
Model fitting
Project (part 1)
Project (part 2)
Oral exam
6 ECTS
Weeks
1
2
3
5
6
7
8
9
10
11
12
13
14
15
We are here
Q&A and Scala part 2
Fasnacht
Exercise 1 due
Q&A
Exercise 2
Q&A
Report 1
Q&A
Q&A
Exercise 3
Q&A
Q&A
Report 2

Questions on this part?

Scalismo Lab

- Best used for early exploration of the Scalismo library
- The tool ships with the Exercise sheets and **API doc**
- **Warning**: this is not a programming environment !
  - For serious / heavy usage, better use an IDE
  - For the project, use and IDE
- For the project, we will use the latest version of Scalismo: 0.17

Scala IDEs

- 2 main players
  - Scala IDE (Eclipse based)
  - IntelliJ Idea with Scala plugin (Community Edition)
  - Our preference: IntelliJ

- It is possible to follow the tutorials using the IDE:
  - Use the **console mode** to run the tutorial code

Now:

Scala introduction (Marcel)

Q&A and IDE installation (task 0.2 of Exercise 1)

Next week: Q&A and Scala intro part 2