UNIVERSITY OF TWENTE.

RAM

3D Computer Vision for Medical Applications

INTRODUCTION

F.vanderHeijden@utwente.nl

the teaching team

prof. dr. Thomas J.J. Maal	- Radboud UMC	- medical context – 3D technology
prof. Raj Gupta, PhD, MD	- Massachusetts GH	- medical context – machine and deep learning
Can O. Tan, PhD	- Massachusetts GH	- deep learning
Elfi I.S. Hofmeijer, MSc	- UT-RAM	- machine learning and deep learning
dr.ir. Ferdinand van der Heijden	- UT-RAM	- coordinator, 3D vision, machine learning

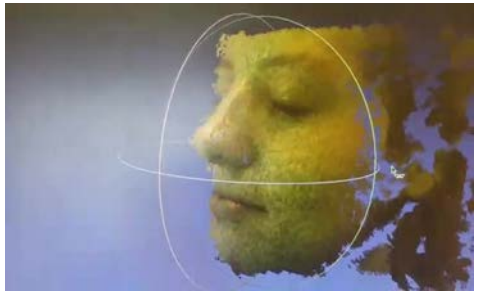
and many teaching assistants and student assistants

Course objectives

After attending the course:

- A student is able to assess whether a clinical problem can benefit from:
  - 3D data technology
  - Machine learning
- He/she is able to implement this scientific, technological approach in the solution of such clinical problems leading to new clinical protocols.
- He/she is able to administer and to carry out this protocol him/herself.

Contents



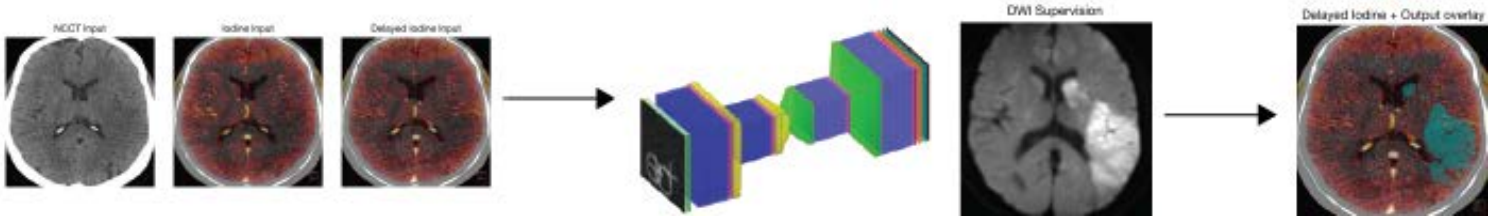
3D Computer Vision for Medical Applications (100hr):

1. 3D acquisition from multiple cameras
   - 3D camera devices
   - Camera models and projective geometry
   - 3D surface reconstruction (from pixels to 3D surface mesh)
2. 3D measurements from camera images
   - 3D pose estimation of cameras and landmarks
   - key points
   - visual navigation
3. 3D mesh manipulation
   - representations
   - registration
   - simplifications and repair
   - 3D key points

Contents

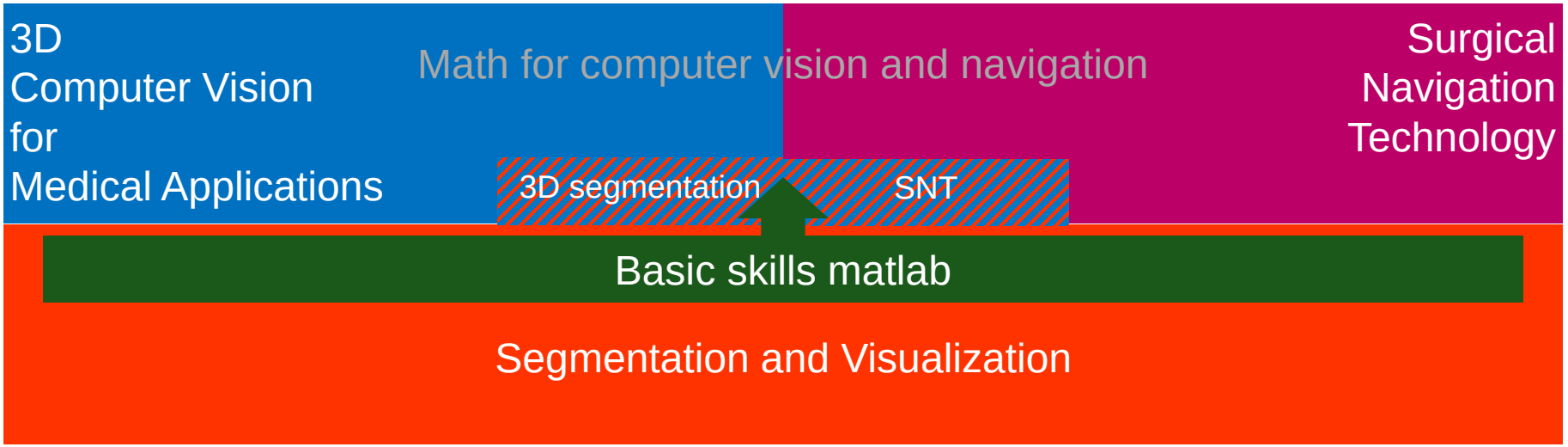
Machine learning and Deep learning for medical applications (40hr):

- the ML-DL paradigm, how to learn from examples:
  - setting up the data sets
  - learnable parameters and hyperparameters
- Classifiers
  - Naive Bayesian, kNNR, Support Vector Machines, …
- Neural networks:
  - feedforward neural network with back propagation
  - deep learning neural network
  - saliency map
- Applications to medical data
  - medical context



Relation with other courses

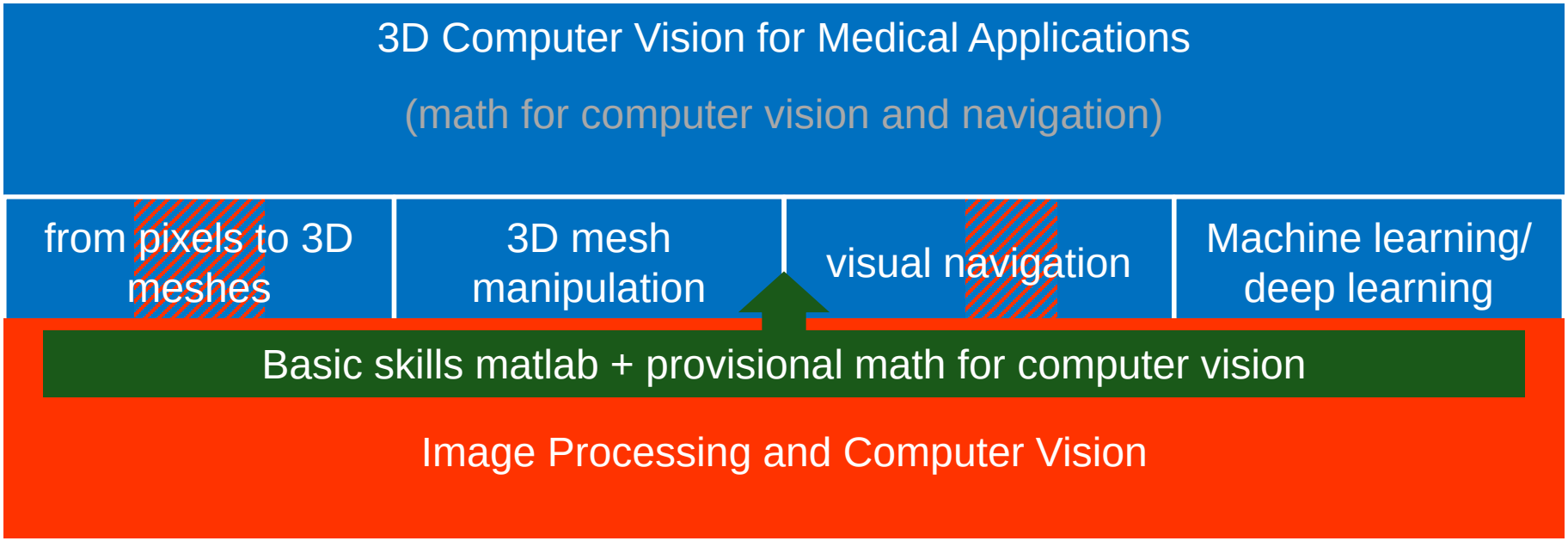
TM-MII students



overlap

Relation with other courses

BME students



Note:

- the syllabi are the primary source of information
  - much in-depth knowledge
  - self-contained text
- aim of the lectures is to gather up the threads
- lectures will often heavily overlap with lectures in IPCV.

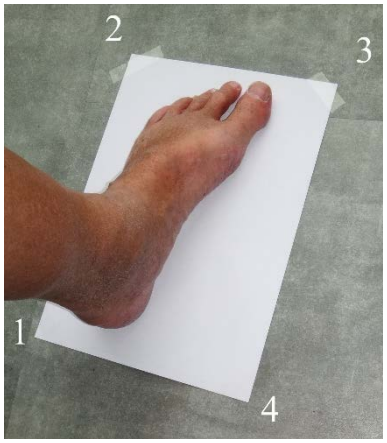
Educational formats of 3DCVMA

3D computer vision for medical applications

- Lectures → zoom conferences
  - Clinical context and motivation
  - Common threads (often overlapping IPCV)
- 4 Matlab exercises (mandatory, individual) using exercise books
- Hands-on experience with 3D cameras → cancelled
- Project (group of 2 students)
- Poster presentation + oral exam (individual) → 21 June – 25 June

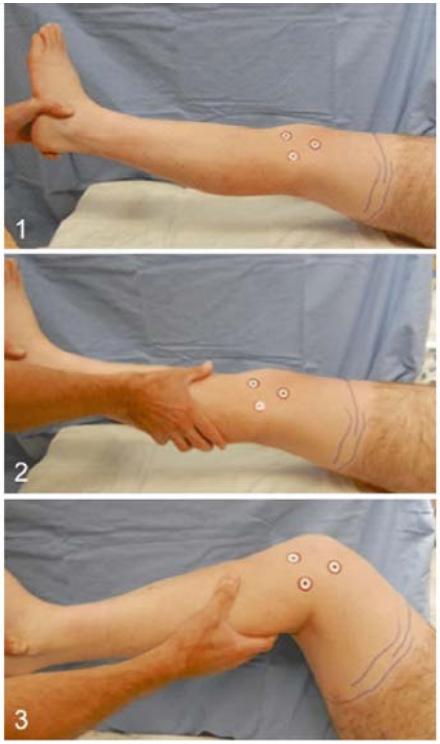
Machine Learning for Medical Applications

- 7 June – 11 June: 1 week 8 hours/day
- written exam 18 June
- educational formats will follow later



example of an exercise: can we measure the shoe size using this image?

the project: assessment of ACL injury



anterior cruciate ligament injury

possible 3D geometrical parameters:

- 3D rotation axis in the knee joint during flexion
- maximum rotation angle
- shift of rotation axis during flexion
- maximum translation of lower leg wrt upperleg

Study materials of 3DCVMA

- Syllabi covering the whole theory; includes useful hints for Matlab
- Lecture sheets and hand-outs.
- Exercise books
- data (images, stereo images, calibration images, etc)
- Software: Matlab 2020a

Assessment

3DCVMA: 67%
ML: 33%

3DCVMA:

- 4 exercise books (pdf forms) 25%
- poster presentation project + oral exam 42%

ML:

- 5 exercise books (pdf books) 20%
- 1 written exam (18 June) 13%

program: see canvas

due dates exercise:

- 7-May exercise 1
- 16-May exercise 2
- 20-May exercise 3
- 6-June exercise 4

due date project

- 21 June

course Machine Learning:

- 7-11 June (40 hours)

written exam ML:

- 18 June

poster presentation + oral:

- 21-25 June

when		how	who	topics
22-Apr	15:45	lecture	T Maal	- general introduction - motivation - medical context
			F.van der Heijden	- outline of the course - organization
23-Apr	13:45	lecture	F. van der Heijden	- homogeneous coordinates - geometrical transforms - homographies - vanishing points - camera models - virtual camera rotations
23-Apr	17.30			**start exercise 1 "measuring the size of a foot"**
07-May	23:59			**deadline exercise 1**
29-Apr	15:45	lecture	F. van der Heijden	- corner detection - key point detection
30-Apr	13:45	lecture	F. van der Heijden	- key point matching - robust estimation: ransac
30-Apr	17.30			**start exercise 2: "key point matching"**
16-May	23:59			**deadline exercise 2**
06-May	15:45	lecture	F. van der Heijden	- epipolar geometry and stereo rectification - stereo matching
07-May	13:45	lecture	F. van der Heijden	- epipolar geometry and stereo rectification - stereo matching
07-May	9:30			**start exercise 3: 3D surfacce reconstruction**
20-May	23:59			**deadline exercise 3**
20-May	15:45	lecture	F. van der Heijden	- Intro Mesh manipulation -- Basic Mesh Representation -- Mesh Sources -- Approximating Meshes
21-May	13:45	lecture	F. van der Heijden	- 3D measurements from camera images
21-May	17.30			**start exercise 4: Mesh manipulation**
06-Jun	23:59			**deadline exercise 4**
27-May	15:45	lecture	F. van der Heijden	- visual navigation
28-May	13:45	lecture	F. van der Heijden	- 3D measurements from camera images
28-May	17.30			**start project:** **"3D measurements and tracking"**
7 June to 11 June			**Gupta et al**	**Machine Learning**
18-Jun	**9:00**			**written test Machine Learning**
21 June to 25 June				poster presentation + oral exam Computer Vision

- Program is indicative. Changes will be published at Canvas
- Detailed program for ML will follow.