ISM Project 2025/2026

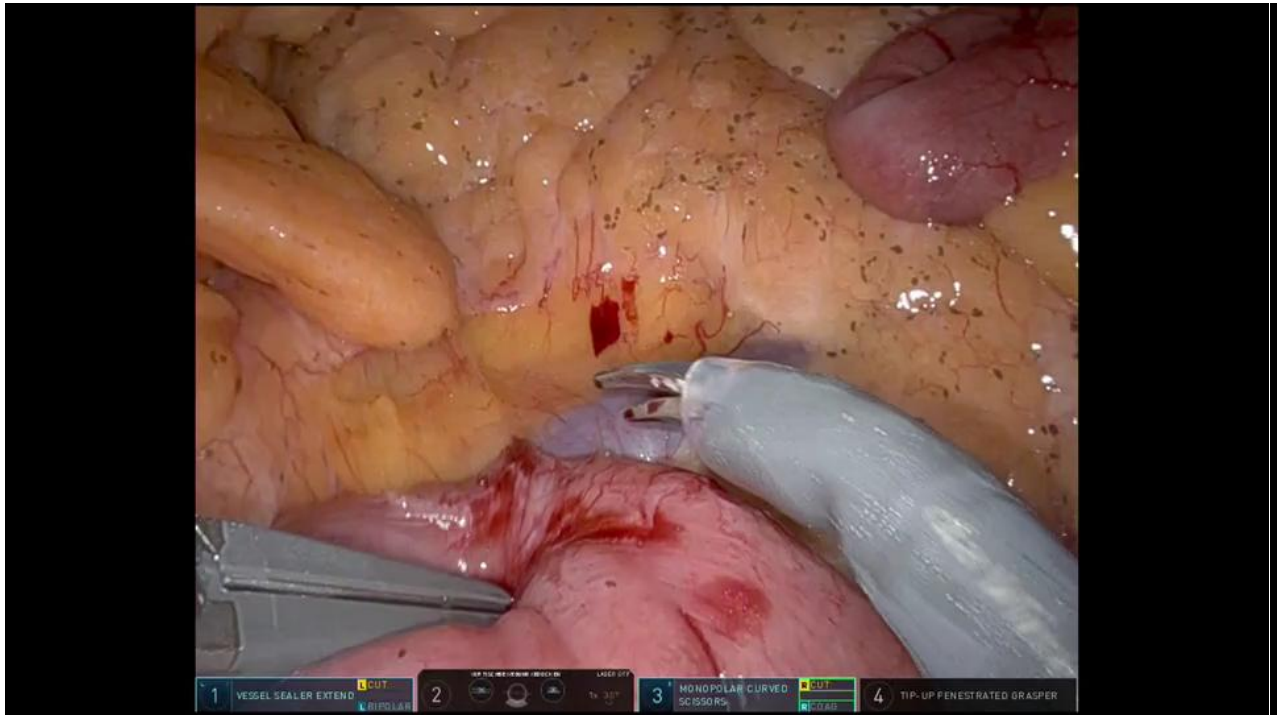
Intelligent Systems Project Introduction 25/26

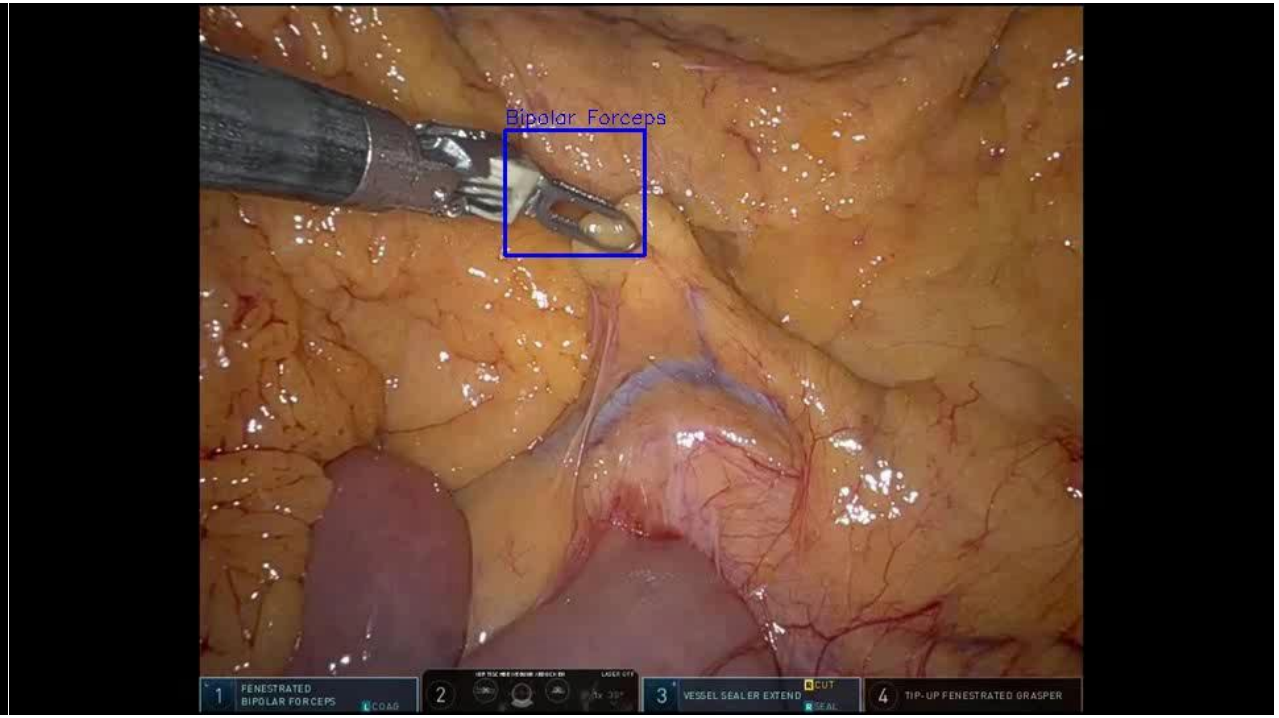
Disclaimer!

Blood and real surgical incisions are shown in the next slides

ISM Project 2025/2026 - Motivation

Robot-assisted Surgery





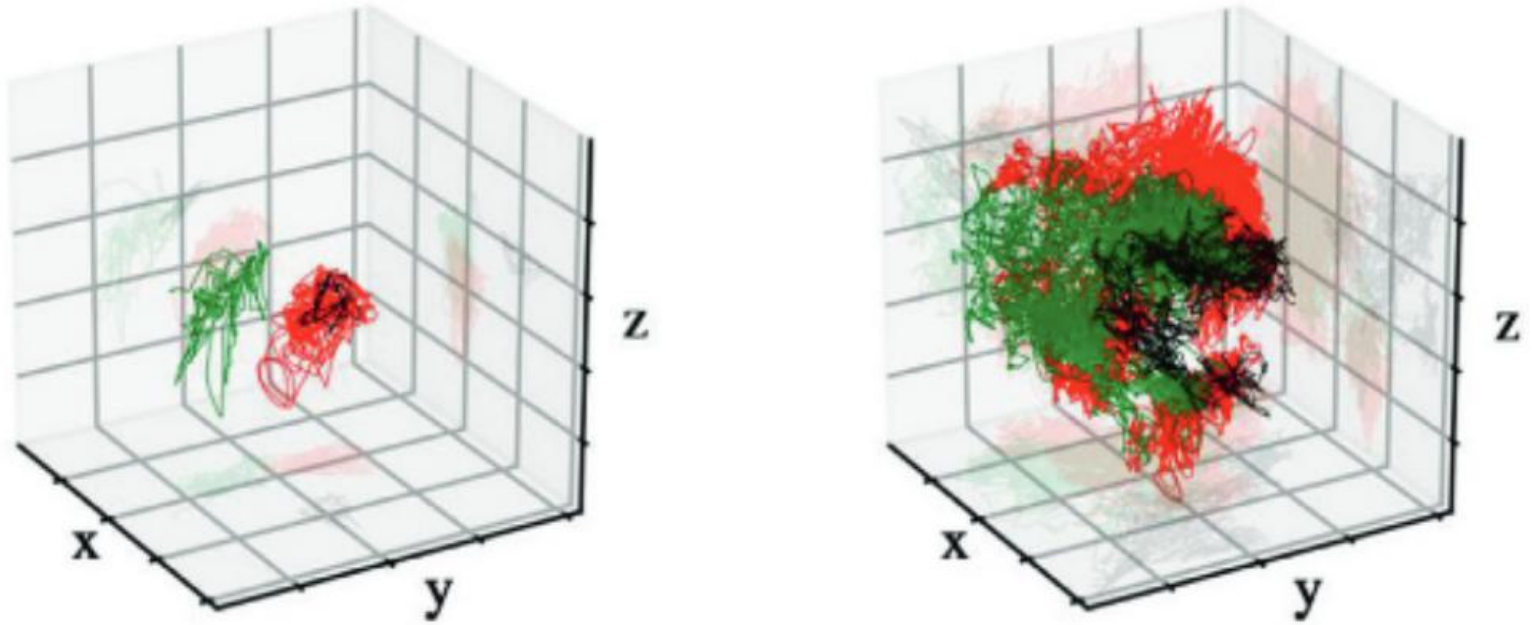
What surgical instruments are currently present? **Surgical Instrument Classification**

Where are the surgical instruments? **Surgical Instrument Detection/Localization**

ISM Project 2025/2026 - Motivation

Who is the expert, Who is the novice?

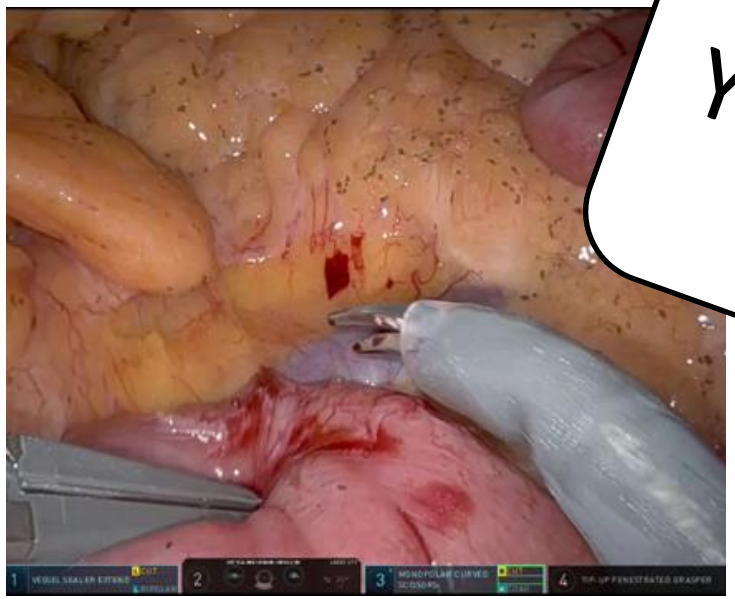
Bladder mobilization:



Nagyné Elek, Renáta, and Tamas Haidegger. "Robot-assisted minimally invasive surgical skill assessment—Manual and automated platforms." *Acta Polytechnica Hungarica* 16.8 (2019): 141-169.

ISM Project 2025/2026 - Motivation

Task 1: Instrument Classification



You work on this in Phase 1

Monopolar Curved Scissors ✓

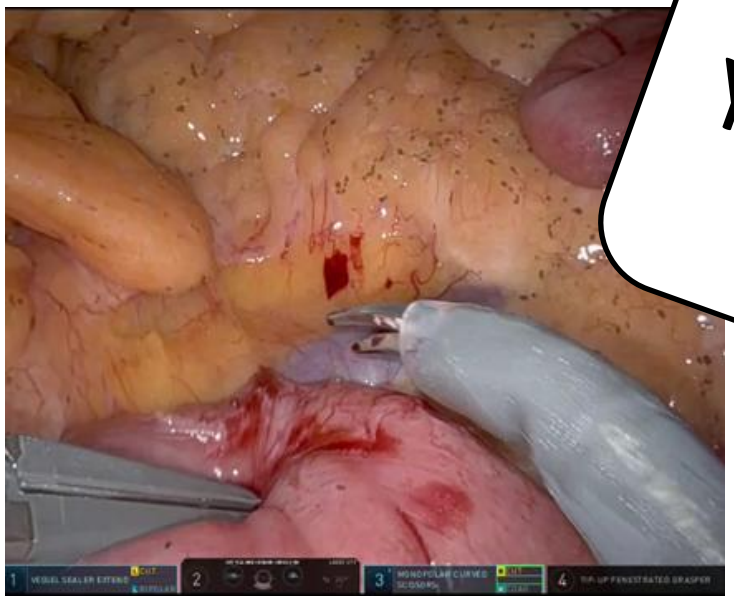
Vessel Sealer ✓

asp Forceps ✗

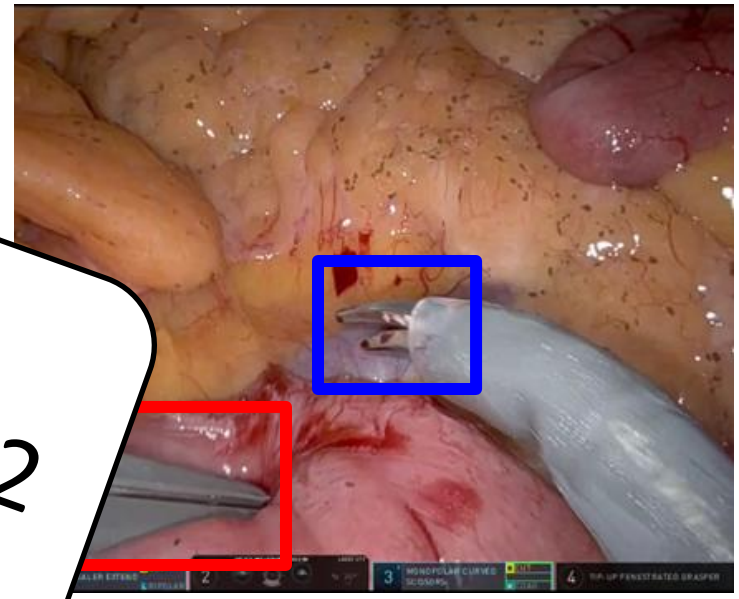
edle Driver ✗

ISM Project 2025/2026 - Motivation

Task 2: Instrument Localization



You work on this in Phase 2



Scissors (x1, x2, y1, y2)

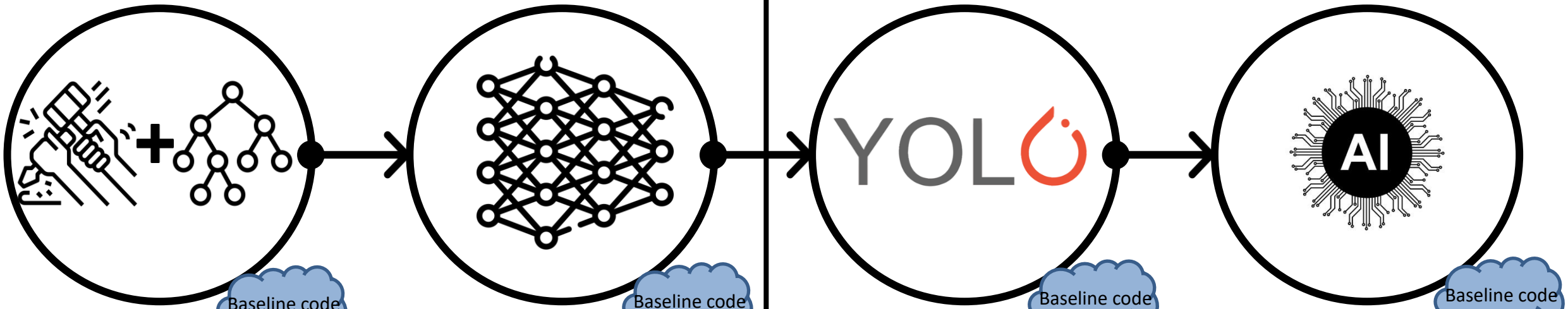
Sealer (x1, x2, y1, y2)

ISM Project 2025/2026 - Motivation

Evolution of Machine Learning Algorithms

Phase 1: Instrument Classification

Phase 2: Instrument Localization



Phase 1a:
Develop & apply image processing methods for feature extraction
Use traditional machine learning (e.g. Support Vector Machines) for surgical instrument classification

Phase 1b:
Develop & train convolutional neural networks for surgical instrument classifiaction with „automatic“ feature extraction from images

Phase 2a:
Optimize the training dataset & train object detection models (Yolo, DETR, etc.) for surgical instrument classification & localization, architectures are fixed

Phase 2b:
Fixed Architectures and Fixed Data
Improve Prompts (Prompt Engineering) and Post Processing to achieve best results

ISM Project 2025/2026 - Structure

Prof. Alexander Schlaefer
schlaefer@tuhh.de

Lennart Maack
lennart.maack@tuhh.de

Adrian Rudloff
adrian.rudloff@tuhh.de

Intelligent Systems in Medicine
Winter term 2025/26

Medical Technology | Intelligent Systems

Date	Lecture (15:00-18:00)	Tutorial	Project Milestone
16.10.25 (Do.)	ECIU On-Boading (ECIU students only)	-	-
17.10.25 (Fr.)	General Introduction Search & Optimization (S&O)	-	-
20.10.25 (Mo.)	-	-	-
24.10.25 (Fr.)	(S&O) / Project Introduction	-	Project start
27.10.25 (Mo.)	-	-	-
30.10.25 (Do.)	-	-	Q&A (16:30 -17:30)
31.10.25 (Fr.)	Holiday	Holiday	Holiday
02.11.25 (So.)	-	-	Status Report #1
03.11.25 (Mo.)	-	S&O (TUHH only)	-
07.11.25 (Fr.)	Simple Learning	-	Data Handling & Setup
10.11.25 (Mo.)	-	-	-
13.11.25 (Do.)	-	-	Q&A (16:30 -17:30)
14.11.25 (Fr.)	Neural Networks and Computer Vision	-	-
16.11.25 (So.)	-	-	Status Report #2
17.11.25 (Mo.)	-	Classifier/Metrics (TUHH only)	-
21.11.25 (Fr.)	Deep Learning	-	Project Phase 1a
11.01.26 (So.)	-	-	Status Report #5
12.01.26 (Mo.)	-	-	-
15.01.26 (Do.)	-	-	Q&A (16:30 -17:30)
16.01.26 (Fr.)	-	-	Project Phase 2b
19.01.26 (Mo.)	-	Recap for exam	-
23.01.26 (Fr.)	-	-	Project presentation
26.01.26 (Mo.)	-	-	-
30.01.26 (Fr.)	-	-	Deadline Report

ISM Project 2025/2026 – Question & Answer Session

Date	Lecture (15:00-18:00)	Tutorial	Project Milestone
16.10.25 (Do.)	ECIU On-Boading (ECIU students only)	-	-
17.10.25 (Fr.)	General Introduction Search & Optimization (S&O)	-	-
20.10.25 (Mo.)	-	-	-
24.10.25 (Fr.)	(S&O) / Project Introduction	-	Project start
27.10.25 (Mo.)	-	-	-
30.10.25 (Do.)	-	-	Q&A (16:30 -17:30)
31.10.25 (Fr.)	Holiday	Holiday	Holiday
02.11.25 (So.)	-	-	Status Report #1
03.11.25 (Mo.)	-	S&O (TUHH only)	-
07.11.25 (Fr.)	Simple Learning	-	Data Handling & Setup
10.11.25 (Mo.)	-	-	-
13.11.25 (Do.)	-	-	Q&A (16:30 -17:30)
14.11.25 (Fr.)	Neural Networks and Computer Vision	-	-
16.11.25 (So.)	-	-	Status Report #2
17.11.25 (Mo.)	-	Classifier/Metrics (TUHH only)	-
21.11.25 (Fr.)	Deep Learning	-	Project Phase 1a

- Join the Q&A sessions (find dates for Q&A sessions in the schedule) if you have specific questions regarding the project
- You might wait a short time in the queue
- The link to the Q&A sessions: https://tuhh.zoom.us/j/8291523418
- Not mandatory
- *You can also ask questions per mail

ISM Project 2025/2026 – Status Reports

Date	Lecture (15:00-18:00)	Tutorial	Project Milestone
16.10.25 (Do.)	ECIU On-Boading (ECIU students only)	-	-
17.10.25 (Fr.)	General Introduction Search & Optimization (S&O)	-	-
20.10.25 (Mo.)	-	-	-
24.10.25 (Fr.)	(S&O) / Project Introduction	-	Project start
27.10.25 (Mo.)	-	-	-
30.10.25 (Do.)	-	-	Q&A (16:30 -17:30)
31.10.25 (Fr.)	Holiday	Holiday	Holiday
02.11.25 (So.)	-	-	Status Report #1
03.11.25 (Mo.)	-	S&O (TUHH only)	-
07.11.25 (Fr.)	Simple Learning	-	Data Handling & Setup
10.11.25 (Mo.)	-	-	-
13.11.25 (Do.)	-	-	Q&A (16:30 -17:30)
14.11.25 (Fr.)	Neural Networks and Computer Vision	-	-
16.11.25 (So.)	-	-	Status Report #2
17.11.25 (Mo.)	-	Classifier/Metrics (TUHH only)	-
21.11.25 (Fr.)	Deep Learning	-	Project Phase 1a

- Nominate **one project manager** per group, responsible for sending the status reports
- Status report should include the following:
  - What has been done **by whom** since the last status report?
  - Did problems occur, if yes, what?
  - What is planned until the next status report?
  - Provide key points, be detailed but precise
  - File format must be **.pdf**
  - **Status Report #1 provide information on whether each team member will actively participate in the project and who will be the “project manager”**
- Send status report via mail to Lennart.maack@tuhh.de, Adrian.rudloff@tuhh.de
- Find the deadline for sending the status report in the schedule

ISM Project 2025/2026 – Meet your Group

Meet your Group (~10 min)

(zoom breakout sessions)

Questions for your meeting:

- What is your background?
- What is your (practical) programming/machine learning/project management knowledge?
- Have you seen a (robotic) surgery live in person before?
- What do you expect from the project?
- Talk about who might be the group leader for writing the status reports

ISM Project 2025/2026 – Meet your Group

Group 1

Aasma	Ahamed
Md Amin	Md Amin
Sharjeel	Ahmad
Bartosz	Sawicki

Group 2

Kathrin	Biri
Johann Magnus	Strunck
Lakshya	Kathayat
Thuso	Sehloho

Group 3

Grace Divine	Cakeu Fobasso
Mayank	Rawat
Abdulkareem	Eid
Theodor	Damian

Group 4

Merve	Sarısoy
Ankit	Rathore
Binson	Joseph
Taha	Ahmed

Group 5

Lynn	Wagner
Mahesh	Pathare
Mihails	Jersovs
Hande	Safiye Erdal

Group 6

Mehmet Emin	Zaza
Rampur	Gowramma Manvitha
Vishwesh Rajendra	Jagtap
Dovile	Kuiziniene

Group 7

Valentin	Weichsel
Yehia	Assi
Pourassad	Mohammadhossein
Anna	Ferrari

Group 8

Jan	Sudhoff
Gayathri	Shiburaj
Kevin Roshan	Peter
Martin	Tosheski

Group 9

Marcel Lionel	Nkola Djuatio
Shivangi	Pathak
Farhan	Shahriyar
Md Abdur	Rahman Akash

Group 10

Jonas	Neuburg
Riyasha Hiteshkumar	Lad
Wiktor Stanislaw	Tumilowicz
Marc Capillas	Nosàs

Group 11

Yussra	Hussein
Konrad Daniel	Galek
Komail	Butt
Leonardo	Agostini

Group 12

Pascal Manuel	Martins Saraiva
Spoorthi	Gudagunti
Abdullah	Darwish
Manali Suha	Bansode

Group 13

Qianxun	Li
Sahiqa	Asim
Mertcan	Catak
Nicolas	Stephan

Group 14

Manuel	Gatzke
Sharvari	Bhagwat
Yusuf	Bardolia
Jesvin	Varghese

Group 15

Abdul Rehman	Memon
Rita	Sardinha Bernardo Cabral Barbosa
Rienke	Mooiweer
Salman	Khan

Group 16

Arnas	Zdanevičius
Vilius	Gečiauskas
Paulius	Dzvankauskas

ISM Project 2025/2026 – Data Handling – Naming Convention

Date	Lecture (15:00-18:00)	Tutorial	Project Milestone
16.10.25 (Do.)	ECIU On-Boading (ECIU students only)	-	-
17.10.25 (Fr.)	General Introduction Search & Optimization (S&O)	-	-
20.10.25 (Mo.)	-	-	-
24.10.25 (Fr.)	(S&O) / Project Introduction	-	Project start
27.10.25 (Mo.)	-	-	-
30.10.25 (Do.)	-	-	Q&A (16:30 -17:30)
31.10.25 (Fr.)	Holiday	Holiday	Holiday
02.11.25 (So.)	-	-	Status Report #1
03.11.25 (Mo.)	-	S&O (TUHH only)	-
07.11.25 (Fr.)	Simple Learning	-	Data Handling & Setup
10.11.25 (Mo.)	-	-	-
13.11.25 (Do.)	-	-	Q&A (16:30 -17:30)
14.11.25 (Fr.)	Neural Networks and Computer Vision	-	-
16.11.25 (So.)	-	-	Status Report #2
17.11.25 (Mo.)	-	Classifier/Metrics (TUHH only)	-
21.11.25 (Fr.)	Deep Learning	-	Project Phase 1a

Backgrounds:

- 00 Green Background
- 01 Tissue Background
- 02 Tissue with steam
- 03 Tissue with disturbances

Instruments (Intuitive DaVinci):

- 00 No Instrument
- 01 Large Needle Driver
- 02 Prograsp Forceps
- 03 Monopolar Curved Scissors

Training & Test Data

- Raw Video Data (~50GB) is provided
- Baseline Code includes some labeled training data for classification (~3000 labeled images) and localization (~400 labeled images)
- Test data is hidden and used for evaluation

Examples

b00_i01_a02_20240813_160653_left.avi
Green background, instrument: large needle driver, the performed action is closing of the instrument. The instrument is open at the beginning and will be closed at the end of the video

b01_i02_a01_20240815_153231_left.avi
Tissue background, instrument: prograsp forceps, the performed action is opening of the instrument. The instrument is closed at the beginning and will be open at the end of the video

ISM Project 2025/2026 – Data Handling

Date	Lecture (15:00-18:00)	Tutorial	Project Milestone
16.10.25 (Do.)	ECIU On-Boading (ECIU students only)	-	-
17.10.25 (Fr.)	General Introduction Search & Optimization (S&O)	-	-
20.10.25 (Mo.)	-	-	-
24.10.25 (Fr.)	(S&O) / Project Introduction	-	Project start
27.10.25 (Mo.)	-	-	-
30.10.25 (Do.)	-	-	Q&A (16:30 -17:30)
31.10.25 (Fr.)	Holiday	Holiday	Holiday
02.11.25 (So.)	-	-	Status Report #1
03.11.25 (Mo.)	-	S&O (TUHH only)	-
07.11.25 (Fr.)	Simple Learning	-	Data Handling & Setup
10.11.25 (Mo.)	-	-	-
13.11.25 (Do.)	-	-	Q&A (16:30 -17:30)
14.11.25 (Fr.)	Neural Networks and Computer Vision	-	-
16.11.25 (So.)	-	-	Status Report #2
17.11.25 (Mo.)	-	Classifier/Metrics (TUHH only)	-
21.11.25 (Fr.)	Deep Learning	-	Project Phase 1a

Link

CVAT

1. Convert training video data to frames (e.g. with ffmpeg), create weak labels based on naming conventions (for classification)

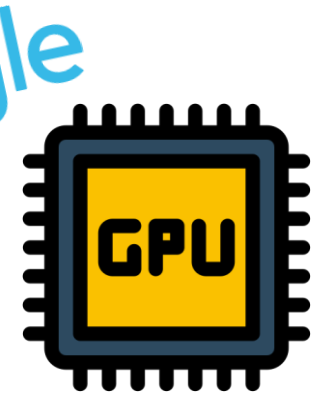
2. Upload video data to CVAT and get to know how CVAT works

3. Use CVAT for bounding box annotation (mostly needed for Phase 2 – Instrument Localization)

ISM Project 2025/2026 – Setup

Date	Lecture (15:00-18:00)	Tutorial	Project Milestone
16.10.25 (Do.)	ECIU On-Boading (ECIU students only)	-	-
17.10.25 (Fr.)	General Introduction Search & Optimization (S&O)	-	-
20.10.25 (Mo.)	-	-	-
24.10.25 (Fr.)	(S&O) / Project Introduction	-	Project start
27.10.25 (Mo.)	-	-	-
30.10.25 (Do.)	-	-	Q&A (16:30 -17:30)
31.10.25 (Fr.)	Holiday	Holiday	Holiday
02.11.25 (So.)	-	-	Status Report #1
03.11.25 (Mo.)	-	S&O (TUHH only)	-
07.11.25 (Fr.)	Simple Learning	-	Data Handling & Setup
10.11.25 (Mo.)	-	-	-
13.11.25 (Do.)	-	-	Q&A (16:30 -17:30)
14.11.25 (Fr.)	Neural Networks and Computer Vision	-	-
16.11.25 (So.)	-	-	Status Report #2
17.11.25 (Mo.)	-	Classifier/Metrics (TUHH only)	-
21.11.25 (Fr.)	Deep Learning	-	Project Phase 1a

Link

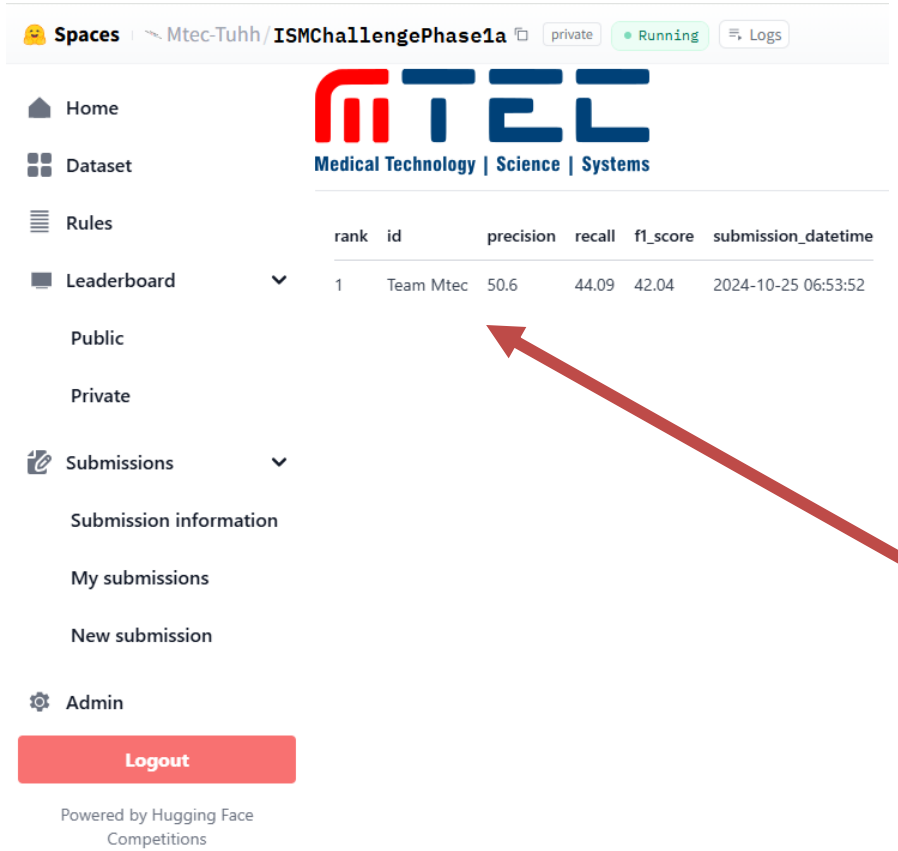


1. Download provided baselines
    1. Link: https://cloud.tuhh.de/index.php/s/76AsGdY34NkQQ5c?dir=/Project/Baselines

2. Familarize with computing (watch the Video Tutorial)

ISM Project 2025/2026 – The Leaderboard

Find competition websites here:
Link



Video Tutorial available
Link

Hugging Face

Try to beat our Baseline

ISM Project 2025/2026 – Project Phase 1a

31.10.25 (Fr.)	Holiday	Holiday	Holiday
02.11.25 (So.)	-	-	Status Report #1
03.11.25 (Mo.)	-	S&O (TUHH only)	-
07.11.25 (Fr.)	Simple Learning	-	Data Handling & Setup
10.11.25 (Mo.)	-	-	-
13.11.25 (Do.)	-	-	Q&A (16:30 -17:30)
14.11.25 (Fr.)	Neural Networks and Computer Vision	-	-
16.11.25 (So.)	-	-	Status Report #2
17.11.25 (Mo.)	-	Classifier/Metrics (TUHH only)	-
21.11.25 (Fr.)	Deep Learning	-	Project Phase 1a

[Link to Competition Phase 1a]

Baseline code available

Video Tutorial available

[Link]

Feature Extraction Method

Image Features

Machine Learning Algorithm

Needle Driver

Classification

Your Tasks

- Develop and apply image processing methods for feature extraction + „traditional“ machine learning (e.g. Support Vector Machines)
- Use provided baseline pipeline for first submission on Hugging Face
- Explore and implement other Feature Extraction & ML methods to improve results and climb the leaderboard

ISM Project 2025/2026 – Project Phase 1b

21.11.25 (Fr.)	Deep Learning	-	Project Phase 1a
24.11.25 (Mo.)	-	-	-
27.11.25 (Do.)	-	-	Q&A (16:30 -17:30)
28.11.25 (Fr.)	Advanced Deep Learning	-	-
30.11.25 (So.)	-	-	Status Report #3
01.12.25 (Mo.)	-	Learning (TUHH only)	-
05.12.25 (Fr.)	External Talk (tba)	-	Project Phase 1b
08.12.25 (Mo.)	-	-	-
11.12.25 (Do.)	-	-	Q&A (16:30 -17:30)
12.12.25 (Fr.)		-	Status Report #4
15.12.25 (Mo.)	-	Advanced Deep Learning (TUHH only)	-

python

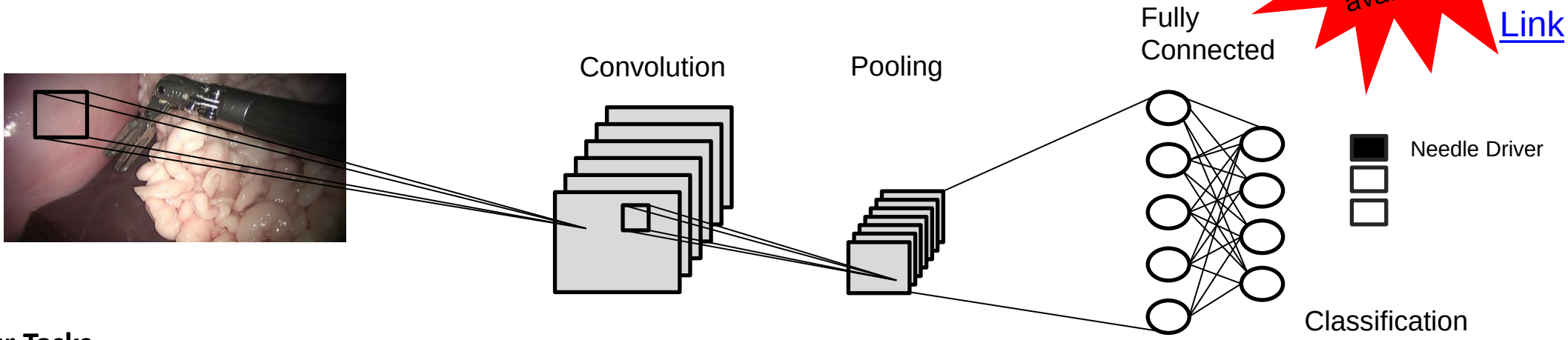
PyTorch

Link to Competition Phase 1b

Baseline code available

Video Tutorial available

Link



Your Tasks

- Develop and apply Convolutional Neural Networks (CNN) for surgical instrument classification
- Use provided baseline pipeline for first submission on Hugging Face
- Explore and implement other CNN methods or try to improve the data (e.g. improve annotations) to improve results and climb the leaderboard

ISM Project 2025/2026 – Project Phase 2a

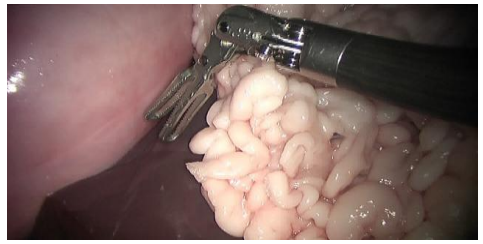
19.12.25 (Fr.)	-	-	-
21.12.25 - 04.01.26	Christmas Break		
05.01.26 (Mo.)	-	-	-
08.01.26 (Do.)	-	-	Q&A (16:30 -17:30)
09.01.26 (Fr.)	-	-	Project Phase 2a
11.01.26 (So.)	-	-	Status Report #3
12.01.26 (Mo.)	-	-	-

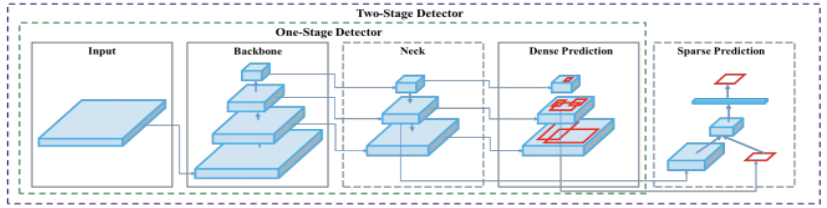
Link to Competition Phase 2a

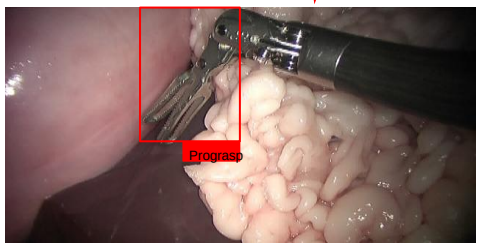
Baseline code available

Video Tutorial available

Link







Localization

Your Tasks

- Tune & train object detection Models (Yolo, etc.) for surgical instrument classification & localization
- Use provided baseline pipeline for first submission on Hugging Face
- Explore and implement other architectures and improve data quality to improve results and climb the leaderboard

ISM Project 2025/2026 – Project Phase 2b

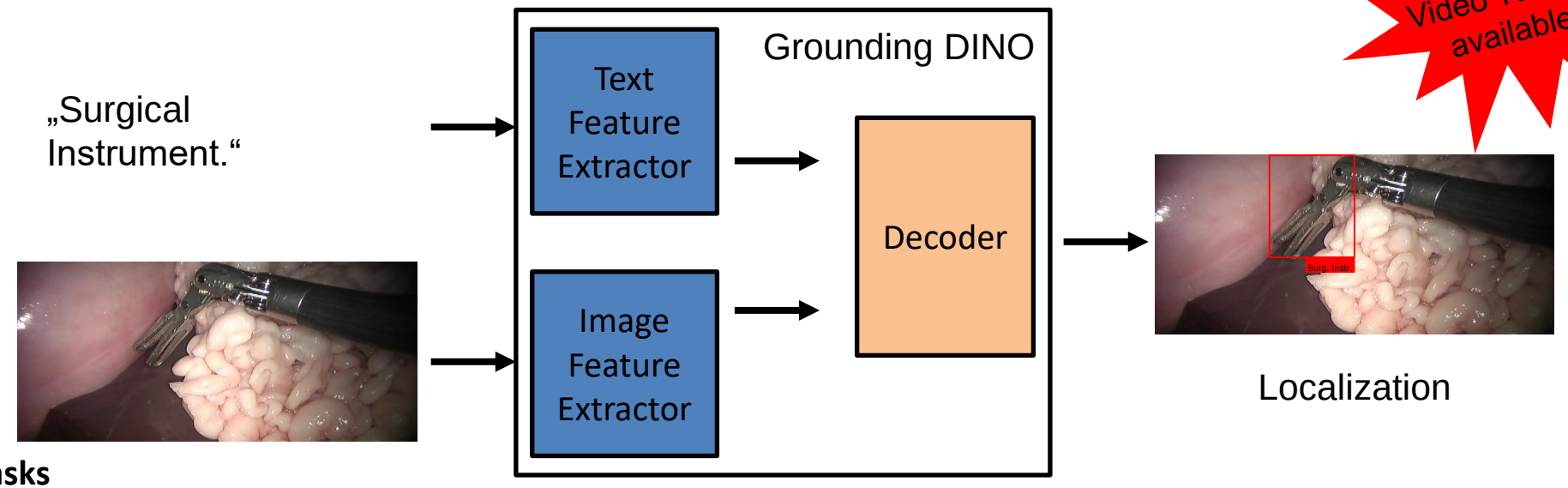
19.12.25 (Fr.)	-	-	-
21.12.25 - 04.01.26	Christmas Break		
05.01.26 (Mo.)	-	-	-
08.01.26 (Do.)	-	-	Q&A (16:30 -17:30)
09.01.26 (Fr.)	-	-	Project Phase 2a
11.01.26 (So.)	-	-	Status Report #5
12.01.26 (Mo.)	-	-	-
15.01.26 (Do.)	-	-	Q&A (16:30 -17:30)
16.01.26 (Fr.)	-	-	Project Phase 2b

Link to Competition Phase 2b

Baseline code available

Video Tutorial available

Link



Your Tasks

- Use Prompt Engineering to localize surgical instruments with foundation models (e.g. Foundation DINO)
- Use provided baseline pipeline for first submission on Hugging Face
- Investigate the right prompts and use post-processing methods to improve your results and move up the leaderboard

ISM Project 2025/2026 – How to successfully finish the project 1/2

How to successfully finish the project

- Submit the status reports by each deadline (02.11.25, 16.11.25, 30.11.25, 12.12.25, 11.01.26)
- Submit your solution to the competetion via HuggingFace by each phase deadline/milestone (21.11.25, 05.12.25, 09.01.26, 16.01.26)
- Present your solutions during the Project Presentation Day (23.01.2026)
    - 10-12 minutes presentation + 3-5 min Q&A
- Submit your scientific report (30.01.2026)
- Have fun, learn a lot and try to win the challenge

ISM Project 2025/2026 – How to successfully finish the project 2/2

How to successfully finish the project – The Scientific Report

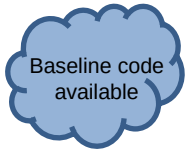
- One scientifc report per group
  - ECIU students do not have to be involved in the preparation of reports
- 4 pages incl. references (use Latex template from StudIP – will be provided soon)
- Submit as .pdf
- 5-7 references
- Follow the structure: Introduction, Material&Methods, Results, Discussion, Conclusion
- Include important images, tables, metrics and charts!
- Indicate contribution of each student (for bonus points allocation), e.g. in an additional document in short bullet points
- Send by the corresponding deadline at the latest

ISM Project 2025/2026 – How to successfully finish the project

Others

1. Attend Q&A sessions if needed
2. Study video tutorials for understanding each topic in depth
3. Use provided baseline methods (Link) as a starting point

Link



Thank you!

Any Questions?

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Do not hesitate contacting us!