

# **COURSE DESCRIPTION**

## **1. Course title**

Deep learning in practice for medical applications

## **2. Course type**

CPD/ST course for medical physicists

## **3. Scientific field**

Artificial Intelligence/Medical radiation physics

## **4. Short summary of the course**

This is an independent follow-up course to the specialist training course "Artificiell Intelligens inom medicinsk diagnostik – vad behöver en sjukhusfysiker veta?", which was offered in conjunction with Röntgenveckan 2022 and "Artificiell intelligens ur ett sjukhusfysikerperspektiv – ytterligare ett steg på vägen mot mer kunskap", which was offered in conjunction with Nationellt möte om Sjukhusfysik 2023. Participants in this course do not need to have attended the previous courses to benefit from its content, but some basic understanding of AI and machine learning is needed.

The course will begin with an introduction to deep learning in medical applications. Following that, the course will include lectures on the most common deep learning pitfalls, state-of-the-art deep learning research, approaches for handling sensitive data, uncertainties, explainability, etc. Each theoretical session will be followed by a hands-on session. Throughout the course, the hands-on sessions will incrementally build on each other so that they together cover the flow from importing and preparing the data, to constructing, training, and evaluating the deep learning network.

## **5. Target audience**

The course is targeted towards medical physicists, PhD students, scientists, and lecturers. Medical physicists can register to the course using the website for Nationellt möte om Sjukhusfysik 2025. Non-medical physicists can attend subject to availability, please contact the course organizers for information regarding availability.

## **6. Course overview**

In September 2022, the specialist training course "Artificiell Intelligens inom medicinsk diagnostik – vad behöver en sjukhusfysiker veta?" was organized in conjunction with the Radiology Week 2022 and in November 2023, the specialist training course "Artificiell intelligens ur ett sjukhusfysikerperspektiv – ytterligare ett steg på vägen mot mer kunskap", was organized in conjunction with Nationellt möte om Sjukhusfysik 2023. The large number of participants in both these courses indicate that there is a strong desire among medical physicists to learn more about AI. However, in the course evaluations many

participants expressed an interest in taking the knowledge obtained from these theoretical courses further and learn more about how to construct and evaluate AI models.

The purpose of this course is therefore to guide the course participants through the practical steps included in the process of building and evaluating AI models for medical imaging tasks.

The course consists of a mixture of both theoretical presentations and practical hands-on sessions. A mandatory pre-course consisting of programming tasks, followed by a digital pre-course meeting where these programming tasks are discussed will be held.

## **7. Expected learning outcomes**

### **Knowledge and understanding**

- Gain knowledge about the basic concepts in AI.
- Practical knowledge in building and modifying AI architectures.
- Practical knowledge about training AI models.
- Practical knowledge about quality metrics, their meaning, and evaluating AI models.
- Gaining experience on virtual environments for AI software, essential when using Python.
- Practical knowledge about data preparation for training AI models.
- Understand common pitfalls in deep learning, and the reproducibility crisis.

### **Ability and skills**

- Build an end-to-end pipeline from DICOM loading to evaluating trained models for medical imaging tasks.
- Understanding and exploring the effects of data quality for AI-based products.
- Implementing widely used model architectures, and their training strategies.
- Compare the available quality metrics commonly used for the tasks at hand.

### **Assessment and attitude**

- Have a healthy attitude towards the usefulness, and limitations of AI in the healthcare environment.
- Approaching already existing AI-based solutions with a critical eye (e.g. data quality, model architecture, evaluation metrics).

## 8. Programme

### SCHEDULE

<b>Monday 11/11-2024</b>	<b>TITLE</b>	<b>LECTURER/PRESENTER</b>
13:00-13:15	Introduction	Attila Simkó, Josef Lundman
13:15-14:00	Presentation: Introduction to deep learning in medical applications	Attila Simkó, Josef Lundman
14:00-15:00	Hands-on session: Loading, managing different medical data formats	Attila Simkó, Josef Lundman
15:00-15:30	COFFEE	
15:30-16:15	Presentation: Overfitting, underfitting, the most common deep learning pitfalls	Saeideh Ghanbari Azar
16:15-17:00	Hands-on session: Converting data to numerical arrays, normalization, augmentation + technical support if needed	Attila Simkó, Josef Lundman
19:00	DINNER	
<b>Tuesday 12/11-2024</b>	<b>TITLE</b>	<b>LECTURER/PRESENTER</b>
08:00-08:45	Presentation: SOTA deep learning research with medical applications	Lorenzo Tronchin
08:30-09:30	Hands-on session: Preparing the data for the tasks at hand	Attila Simkó, Josef Lundman
9:30-10:00	COFFEE	
10:00-11:00	Presentation: nnUNet, and the pros and cons of designing your own model architectures	Lorenzo Tronchin
11:00-12:00	Hands-on session: A layer-by-layer discussion of our implemented model architectures	Attila Simkó, Josef Lundman
12:00-13:00	LUNCH	
13:00-14:00	Presentation: Federated learning, and other approaches to handle sensitive medical data	Attila Simkó

14:00-15:00	Hands-on session: Go through the steps of model training, gradient updates	Attila Simkó, Josef Lundman
15:00-15:30	COFFEE	
15:30-16:15	Presentation: Model uncertainties, explainability, image quality metrics and their correlation to human perception	Attila Simkó
16:15-17:00	Hands-on session: The visualization of model predictions, and performance reporting	Attila Simkó, Josef Lundman
19:00	DINNER	
<b>Wednesday 13/11-2024</b>	<b>TITLE</b>	<b>LECTURER/PRESENTER</b>
08:00-08:45	Presentation: The reproducibility crisis, finding the limitations of your models	Attila Simkó
08:30-09:30	Hands-on session: Test the trained models on real-world data, show clear fails, surprising successes, borderline scenarios	Attila Simkó, Josef Lundman
9:30-10:00	COFFEE	
10:00-11:00	Presentation: Using deep learning in research, today	Patrik Brynolfsson
11:00-11:45	Presentation: Using deep learning in research, tomorrow	Attila Simkó, Josef Lundman
11:45-12:00	Course evaluation	
12:00-13:00	LUNCH	

**Lecturers:**

Attila Simkó, PhD, Department of Computing Science, Umeå University

Josef Lundman, PhD, Medical Physicist and Software developer, CIMT/Strålningsfysik, Norrlands Universitetssjukhus, Umeå

Lorenzo Tronchin, PhD, Postdoc, Department of Computing Science, Umeå University

Patrik Brynolfsson, PhD, Medical Physicist, Strålningsfysik, Skånes Universitetssjukhus, Lund.

Saeideh Ghanbari Azar, M.Sc, PhD-student, Department of Computing Science, Umeå University

## 9. Methodology

### Pedagogical methods

Presentations  
Hands-on sessions

### Course material

Lecture notes, programming material, literature (<https://www.deeplearningbook.org>)

### Required preparations

Complete the programming tasks that are provided to participants, via Google Colab, after registration and attend the pre-course digital meeting that will be held 24 October 2024 at 10-12 CET.

The hands-on sessions will require access to a computer, so the course participants are required to bring their own laptop and ensure that the computer have access to Google Colab.

### Course exam

The course will not contain a course examination.

## 10. Registration of completed course

### Registration of CPD points

The course should be registered according to the description on the website of Sjukhusfysikerförbundet <http://www.sjukhusfysiker.se/cpd-specialist>.

### Registration of ST points

The medical physicists on the ST programme will present the content of the course at her/his own local institution. A certificate, according to the template, of completed specialist course is sent to the National Council for specialist courses in radiation physics: [kursradet@sjukhusfysiker.se](mailto:kursradet@sjukhusfysiker.se).

## 11. Course evaluation

The Lipus method for course evaluation will be used.

## 12. Practical information

### Start date

11 November 2024

### End date

13 November 2024

**Course location**

Strömstad Spa & Resort, Strömstad

**Deadline for registration**

30 September 2024

**Course fee**

Course only (including accommodation and meals (11/11–13/11) 6410 SEK.

Course and participation in the national meeting for medical physicists (including accommodation and meals 11/11–15/11) 8820 SEK.

**Travels, meals and accommodation**

Accommodation (2 nights including breakfast) and meals (3 lunches and 2 dinners) are included in the course fee. For course participants also registered for Nationellt möte om Sjukhusfysik 2024, accommodation and meals for the entire meeting (11/11-15/11) are included in the registration fee. Travel arrangements should be made separately by the participants or their employers.

**Number of participants**

Minimum 25 and maximum 60.

**Language**

English

**Distribution of course information and course materials**

An email containing information regarding the course, including the pre-course programming tasks, will be sent to the participants after course registration. Lecturer notes will be sent to the participants after course completion.

**Requirements for course completion**

Completion of the pre-preparation tasks, attendance on the pre-course digital meeting and all lectures on the course, as well as participation in the hands-on sessions.

**Course certificate**

All attendees will receive a Certificate of attendance, signed by the course directors.

**Contacts**

For practical questions:

Angelica Svalkvist, [angelica.svalkvist@vgregion.se](mailto:angelica.svalkvist@vgregion.se)

Maria Larsson, [maria.ev.larsson@vgregion.se](mailto:maria.ev.larsson@vgregion.se)

For questions regarding pre-preparation tasks:

A digital meeting will be held 24 October 2024 at 10-12 CET, in which there will be opportunity to ask questions and receive guidance regarding the pre-preparation tasks.

## **Additional information**

Information regarding CPD/ST points will be provided after final decision from Kursrådet.

## **Website**

<https://www.sjukhusfysiker.se/nationelltmete2024>

## **13. Course admission**

Participants register to the course using the website for Nationellt möte om Sjukhusfysik 2024 (<https://www.sjukhusfysiker.se/nationelltmete2024>). A confirmation email will be sent to the registered email address after completion of course registration.

## **14. Connection to other courses**

The course is part of a series of courses included in the CPD- and ST programme for Medical Physicists in Sweden.

The course is a standalone course included in a series of courses including AI and deep learning targeting medical physicists. Previous courses have been held in September 2022 (Artificiell Intelligens inom medicinsk diagnostik – vad behöver en sjukhusfysiker veta?) and November 2023 (Artificiell intelligens ur ett sjukhusfysikerperspektiv – ytterligare ett steg på vägen mot mer kunskap). Participation in previous courses is not required for course admission.

## **15. Course organisation**

### **Course organizers**

Angelica Svalkvist, Docent, Medical physicist  
Medicinsk Fysik och Teknik, Sahlgrenska Universitetssjukhuset  
[angelica.svalkvist@vgregion.se](mailto:angelica.svalkvist@vgregion.se)

Maria Larsson, PhD, Medical physicist  
Medicinsk Fysik och Teknik, Sahlgrenska Universitetssjukhuset  
[maria.ev.larsson@vgregion.se](mailto:maria.ev.larsson@vgregion.se)

Attila Simkó, PhD, Staff scientist,  
Department of Diagnostics and Intervention, Umeå University  
[attila.simko@umu.se](mailto:attila.simko@umu.se)

Josef Lundman, PhD, Medical physicist and Software developer  
Centrum för informationsteknik och medicinsk teknik/Strålningsfysik,  
Norrlands universitetssjukhus  
[josef.lundman@regionvasterbotten.se](mailto:josef.lundman@regionvasterbotten.se)

Jonas Andersson, Docent, Medical physicist  
Centrum för informationsteknik och medicinsk teknik/Strålningsfysik  
Norrlands universitetssjukhus  
[jonas.s.andersson@umu.se](mailto:jonas.s.andersson@umu.se)

### **Content**

The lecturers will be responsible for the content of their presentations.

### **Practical course administration**

Medical physicists can register to the course using the website for Nationellt möte om Sjukhusfysik 2025. Non-medical physicists can attend subject to availability, please contact the course organizers to get information regarding availability.

### **Collaboration**

The course is arranged in collaboration with Svensk förening för Radiofysik and Svenska Sjukhusfysikerförbundet.

### **Representative of the target audience**

Andreas Selin (Karolinska Universitetssjukhuset)

## **16. Financing**

The costs for the course will be covered by the registration fees.

### **Other arrangements**

See the programme for Nationellt möte om sjukhusfysik 2024.