Cloud ARtificial Intelligence For pathologY

FOURTH NEWSLETTER – oct 2022

Welcome to the fourth newsletter!

CLARIFY is already three years old and, as it couldn't be otherwise, **many are the events that have taken place thanks to this project**! Lots of congresses attended, published papers, secondments carried out by our ESRs…

In summary, these last months have been full of learning and important events. As for the events, probably the most important and awaited was the **2nd training school** that was held in person in **Granada**, where **we were finally able to meet all of us in person**!

If you want to know more details about the progress of our project, read on, and don't forget to follow us on our **social networks** and visit our **website**.

www.clarify-project.eu

@clarify_project

/Clarify-Project

/Clarify-Project

CLARIFY in a Photo

4 Universities
UPV, UGR, UvA & UiS

3 Hospitals
INCLIVA, SUH & EMC

2 Companies
BitYoga & Tyris Software

12 ERSs

Milestones achieved

| **Monthy meetings** between ESRs and supervisors	**6 secondments** concluded from March to September	**2 Scientific deliverables**	**7 conference papers** since the last newsletter	**7 journal papers** since the last newsletter

www.clarify-project.eu

European Commission

Scientific Deliverables

D2.2. Data and metadata management system

Deliverable 2.2 describes the challenges in managing health data and metadata collected from different hospitals and research institutes, presents possible data and metadata management approaches and platform (see a conceptual concept in the following figure) based on user requirements of the CLARIFY project.
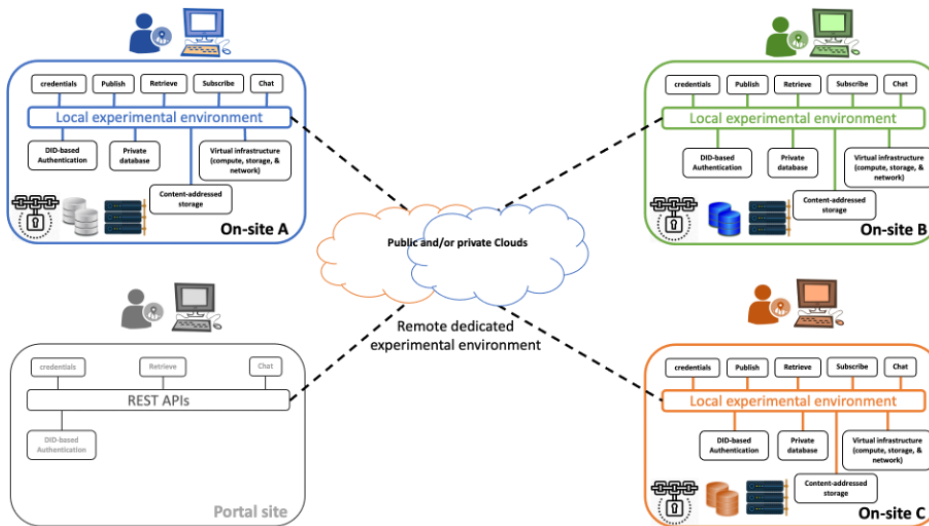
D3.2. Significant Feature Extraction Guidelines

All ESRs of the AI group collaborated on CLARIFY's deliverable for significant feature extraction guidelines (D3.2). After the preprocessing and standardization steps described in the last deliverable, significant features can be efficiently extracted from input WSIs by means of either traditional methods or deep learning-based algorithms. These features then enable more specific medical applications such as the segmentation, diagnosis, or prognosis of the lesions under study. In this deliverable, the different methods used for feature extraction in histology are described, along with general ways to enable their interpretation.

www.clarify-project.eu
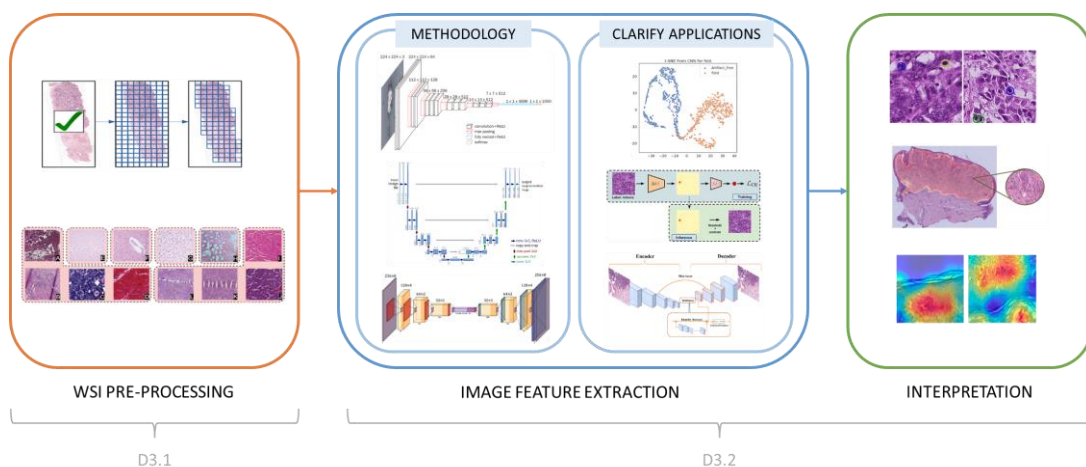
ESR project updates

ESR1: Na Li, Universiteit van Amsterdam: *"Semantic interoperability of digital pathology data via common formal terminology"*

- Published a **short paper** titled "Context-Aware Notebook Search in a Jupyter-Based Virtual Research Environment" on eScience 2022 (18th IEEE International Conference on e-Science).

- **Developed a notebook search engine** that can provide notebook retrieval functionality to users and collect user interaction data.

ESR2: Yuandou Wang, Universiteit van Amsterdam: "*Seamless trusted data sharing techniques*"

- **Collaboration with ESR7** on the work "Federating centralized learning in a private Jupyter notebook to distributed institutions" to cope with the low efficiency challenges in development and deployment in federated learning.

- Discussion with **ESR3** and **ESR4** at UiS about AI pipelines, workflow technologies, and developing image analysis pipelines of whole-silde images.

- Working with **deliverable D2.2** Data and metadata management system.

ESR3: Jiahui Geng, bitYoga AS: "*Taking computation to Data: integrating BigData and Blockchain allowing secure analysis of sensitive health data on-premise*"

- **Secondment at UGR** to learn about Deep Gaussian Processes. There, ERS3 gained knowledge of the Deep Gaussian Process and the application of the Gaussian method in federated learning.

- Attended **PACE Summer School 2022**, to study Energy Informatics.

- Visited the Chair for Decentralized Information Systems and Data Management at the Technical University of Munich.

- Three papers accepted by **IEEE CloudCom2022**.

ESR4: Neel Kanwal, University of Stavanger: *"Preprocessing, segmentation and anonymization of WSI"*

- Published **a journal article**, titled "The devil is in the details", in IEEE Access 2022.

- Published a **conference paper at IVMSP 2022** on the detection of histological artifacts.

- Participated at **NORA 2022 and hAIst 2022 conferences** and made abstract and poster presentations.

- Attended **machine learning summer school at the University of Oxford** to learn about recent trends in biomedical applications.

- Submitted a conference on melanoma detection and localization to ISBI 2023.

www.clarify-project.eu

ESR5: Saul Fuster Navarro, University of Stavanger: *"Extracting diagnostic and prognostic information from histological images of NMIBC"*

- Participated **in NORA 2022 and hAIST conferences**.

- Published a **conference paper** on <u>detection of invasive cancerous areas</u> on NMIBC WSIs was published at **IEEE IVMSP 2022**, along with ESRs 4, 10 and 11.

- **Currently seconded at UPV**. Developing a novel application for BCG treatment response of HR-NMIBC patients using WSI from the first TURBT. The goal is to discriminate responders from non-responders for better treatment strategy assessment.

ESR6: Claudio Fernández - Universitat Politècnica de València: *"Significant feature extraction from WSI for diagnosis and prognosis of TNBC"*

- **Accepted article about Mitosis Detection** at the "23rd International Conference on Intelligent Data Engineering and Automated Learning (IDEAL2022)".

- Participation in a 3-month **secondment at UGR**, where he's learning about probabilistic models and their application to Deep Learning from Professor Rafael Molina.

- Started training and testing a Weakly-Supervised Model for predicting the Molecular Subtypes in Breast Cancer WSIs from the public database BCNB.

ESR7: Laëtitia Launet - Universitat Politècnica de València: *"Deep learning for spitzoid melanocytic lesion (SML) characterization"*

- **Conference paper** presented at **ICIP 2022.**

- **Conference paper accepted at IDEAL 2022**: "Federating Unlabeled Samples: A Semi-Supervised Collaborative framework for Whole Slide Image Analysis."

- **Collaboration with ESR2** on the development of a federated learning tool that leverages the Jupyter Notebook environment to bridge the gap between AI researchers and federated learning, thus reducing the complexity of federated implementations.

- **Collaboration with ESR9 and ESR12** on a systematic review focusing on AI studies for melanocytic lesions analysis.

ESR8: Arne Schmidt - Universidad de Granada: *"Probabilistic large scale crowdsourcing methods for histological image classification"*

- **Secondment at Tyris Software** about software usability **and** a secondment at **INCLIVA** about histopathological diagnosis in the clinical practice.

- **Published several article** about <u>multiple instance learning, WSI preprocessing and probabilistic deep learning</u> in collaborations with the UPV, UiS and Northwestern University (NU).

- Worked on Active Learning for histopathological images in collaboration with NU. The article is going to be submitted in the next weeks.

www.clarify-project.eu

ESR9: Zahra Tabatabaei - Tyris Software S.L.: *"Strategies for cloud-based histological image retrieval"*

- **Conference paper** in IVMSP 2022.

- **Submitted a conference paper** "Self-supervised learning of a tailored Convolutional Auto Encoder for histopathological prostate grading." in IEEE International Symposium on Biomedical Imaging (ISBI)

- Submitted "Deep learning models in Whole Slide Imaging Melanocytic Tumors: A Systematic Review" in Multidisciplinary Digital Publishing Institute (MDPI), a collaboration with ESR7 and ESR12).

- **Secondment at UGR** focused on the analysis of the effect of color normalization on the performance of CBIR. And defining a novel CBIR for spitzoid data set.

ESR10: Farbod Khoraminia - Erasmus Medisch Centrum Rotterdam: *"Improving HR-NMBC diagnosis and prognosis by digital pathology"*

- Submitting a **systematic review to European Urology oncology**, entitled "Artificial intelligence in digital pathology for bladder cancer, hype or hope? A systematic review."

- Developing a **new WSI of 286 high-risk non-muscle-invasive bladder cancer** (HR-NMIBC) patients to predict molecular subtype by analyzing H&E WSIs.

- **Annotating 150 WSIs** for predicting molecular subtype by analyzing H&E WSIs.

- **Expanding annotation dataset** to predict response to BCG treatment for HR-NMIBC patients to 140 annotated WSIs.

ESR11: Umay Kiraz - Helse Stavanger HF: *"Evaluation of TNBC for diagnostic and prognostic by digital pathology"*

- Completing the **dataset of TNBC** with all the clinical information and histopathologic evaluation. Started to annotate interesting features in WSIs.

- **Attended 34th European Congress of Pathology and 18th European Congress on Digital Pathology** to improve her knowledge about breast and digital pathology.

- **Secondment at EMC**, where she learnt more about uropathology and participated research meeting with the department of experimental urology department.

- Currently, **seconded at Tyris** to learn more about AI in digital pathology.

ESR12: Andrés Mosquera-Zamudio - Instituto de Investigación Sanitaria INCLIVA: *"Analysis of the implementation of AI algorithms in the evaluation of spitzoid melanocytic tumours for diagnosis and prognosis"*

- Workshop of **new generation sequencing** at SUH, during his secondment and courses in Python programming language.

- Acquisition of more Spitz Tumors of Unkown Malignant Potential (STUMP) from Canada and Norway.

- **Secondment at SUH** to have a close approach to molecular pathology

www.clarify-project.eu

European Commission

What's happening?

- 7 conference papers
- 7 journal papers
- 6 Secondments
- 12 local training activities
- 2 network training activities

- ## Scientific publications

CONFERENCE PAPERS

37th ACM/SIGAPP Symposium On Applied Computing (ACM SAC 2022) (April 2022)

Neel Kanwal, Giuseppe Rizzo:

Attention-based Clinical Note Summarization

hAIST 2022: Health-related Artificial Intelligence in Stavanger (June 2022)

Neel Kanwal, Farbod Khoraminia, Tahlita Zuiverloon, Chunming Rong, and Kjersti Engan:

Detection of Histopathological Artifacts in Whole Slide Images

2022 IEEE 14th Image, Video, and Multidimensional Signal Processing Workshop (IVMSP 2022) (June 2022)

Neel Kanwal, Saul Fuster, Farbod Khoraminia, Tahlita C.M. Zuiverloon, Chunming Rong, Kjersti Engan:

Quantifying the effect of color processing on blood and damaged tissue detection in Whole Slide Images

2022 IEEE 14th Image, Video, and Multidimensional Signal Processing Workshop (IVMSP 2022) (June 2022)

Saul Fuster, Farbod Khoraminia, Umay Kiraz, Neel Kanwal, Vebjørn Kvikstad, Trygve Eftestøl, Tahlita C.M. Zuiverloon, Emilius A. M. Janssen, Kjersti Engan:

Invasive Cancerous Area Detection in Non-Muscle Invasive Bladder Cancer Whole Slide Images

www.clarify-project.eu

European Commission

2022 IEEE 14th Image, Video, and Multidimensional Signal Processing Workshop (IVMSP 2022) (June 2022)

Zahra Tabatabaei, Javier Oliver, Valery Naranjo, Kjersti Engan:

Residual block Convolutional Auto Encoder in Content- Based Medical Image Retrieval

18th IEEE International Conference on e-Science (eScience 2022) (October 2022)

Na Li, Siamak Farshidi, Riccardo Bianchi, Spiros Koulouzis, Zhiming Zhao:

Context-Aware Notebook Search in a Jupyter-Based Virtual Research Environment
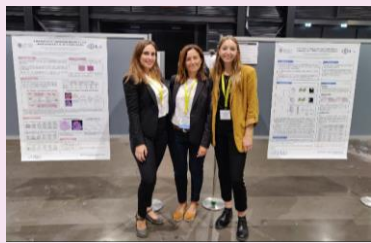
29th IEEE International Conference on Image Processing (ICIP 2022) (October 2022)

Launet, L., Colomer, A., Mosquera-Zamudio, A., Moscardó, A., Monteagudo, C., & Naranjo, V.

A Self-Training Weakly-Supervised Framework for Pathologist-Like Histopathological Image Analysis.

JOURNAL PAPERS

IEEE ACCESS: Efficient Cancer Classification by Coupling Semi Supervised and Multiple Instance Learning (January 2022)

Arne Schmidt, Julio Silva-Rodríguez, Rafael Molina, and Valery Naranjo, doi: 10.1109/ACCESS.2022.3143345.

DATA INTELLIGENCE: Scaling Notebooks as Re-configurable Cloud Worklfows (April 2022)

Yuandou Wang, Spiros Koulouzis, Riccardo Bianchi, Na Li, Yifang Shi, Joris Timmermans, W. Daniel Kissling, Zhiming Zhao doi: 10.1162/dint_a_00140
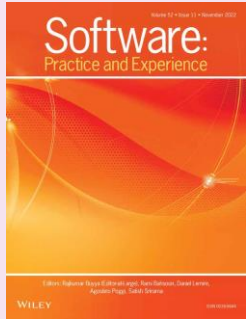
www.clarify-project.eu

JOURNAL OF CLOUD COMPUTING: OpenIaC: open infrastructure as code - the network is my computer. (May 2022)

Chunming Rong, Jiahui Geng, Thomas J. Hacker, Haakon Bryhni, Martin G. Jaatun

doi: 10.1186/s13677-022-00285-7.

SOFTWARE - PRACTICE AND EXPERIENCE: Notebook-as-a-VRE (NaaVRE): From private notebooks to a collaborative cloud virtual research environment (May 2022)

Zhiming Zhao, Spiros Koulouzis, Riccardo Bianchi, Siamak Farshidi, Zeshun Shi, Ruyue Xin, Yuandou Wang, Na Li, Yifang Shi, Joris Timmermans, W. Daniel Kissling

doi: 10.1002/spe.3098

IEEE ACCESS: The Devil is in the Details: Whole Slide Image Acquisition and Processing for Artifacts Detection, Color Variation, and Data Augmentation: A Review (May 2022)

Neel Kanwal, Fernando Pérez-Bueno, Arne Schmidt, Kjersti. Engan and Rafael Molina

doi: 10.1109/ACCESS.2022.3176091

COMPUTER METHODS AND PROGRAMS IN BIOMEDICINE: Deep Gaussian Processes for Multiple Instance Learning: Application to CT Intracranial Hemorrhage Detection (June 2022)

M. López-Pérez, A. Schmidt, Y. Wu, R. Molina, and A.K. Katsaggelos
doi: 10.1016/j.cmpb.2022.106783

COMPUTER IN BIOLOGY AND MEDICINE: "Proportion constrained weakly supervised histopathology image classification" (August 2022)

J. Silva-Rodríguez, A. Schmidt, M. A. Sales, R. Molina, and V. Naranjo,
doi: 10.1016/j.compbiomed.2022.105714

www.clarify-project.eu

European Commission

CLARIFY Second Newsletter - October 2022

- **Events and training**

5-7 Apr 2022

2nd training School took place at the University of Granada. The event was composed of 3 technical lectures by some of the CLARIFY supervisors, 3 master classes by some distinguished members of our External Advisory Board, and 3 workshops to cover relevant transferable skills issues.

21 Jun 2022

ESRs had the pleasure to attend the **3rd CLARIFY Virtual Fieldtrip** titled "How to develop a software application. The importance of the usability" led by Tyris Software, one of our partner organizations. Javier Oliver, founder, and CEO at Tyris Software explained the importance of the user experience in the development of digital products, specifically in the digital product design.

LOCAL TRAINING ACTIVITIES

9-10 Mar 2022

National Network for Breast Cancer – Networking meeting: ESR11 attended and participated in the development of two posters presented at the event, entitled: "Relation between prognostic factors and MicroRNAs (miR-18a/miR-18b) in triple negative breast cancer" and "Comparison of proliferation and other prognostic biomarkers in primary invasive lymph node negative breast cancer in Spain and Norway"

31 May 2022
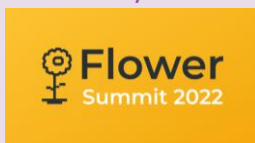
Flower Summit 2022: ESR2 and ESR7 attended the Flower Summit 2022. They attended the conference, where presentations with different approaches to the use of the FLOWER framework and the current challenges of federated learning in different fields took place

9-10 Jun 2022

NORA 2022: ESR4 and ESR5 attented the NORA Annual conference in Stavanger, organized by the Norwegian Artificial Intelligence Research Consortium. In this conference, they presented their abstracts of their ongoing work in the field of Medical Applications and Image Processing. ESR4 talked about the detection of histopathological artifacts in whole slide images, and ESR5 spoked about the Automatic staging of non-muscle invasive bladder cancer.**"**

www.clarify-project.eu

16-18 Jun 2022

ECDP2022: ESR11 attended the 18th European Congress on Digital Pathology celebrated in Berlin, where the latest topics on digital and computational pathology were discussed.

1-4 Jul 2022

EAU 22: ESR10 attended the European Association of Urology Annual Congress which is Europe's biggest urological event. The 37th Annual EAU Congress included a wide range of sessions by urological experts from all around the world, and took place in Amsterdam.

10-16 Jul 2022

ACAES 2022: ESR2 attended the 18th International Summer School on Advanced Computer Architecture and Compilation for High-performance Embedded Systems. This event was organized by the HiPEAC Network.

7-14 Aug 2022

OxML 2022: ESR 4 attended the Oxford Machine Learning Summer School which was organised by AI for Global Goals. The event was organised with the aim of providing the best training in a wide range of advanced topics and developments in machine learning (ML) - including deep learning.

22-26 Aug 2022

Colombian Congress of Pathology: ESR12 participated as a speaker at the 43th Colombian Congress of Pathology, held in Cartagena de las Indias and organised by the Colombian Association of Pathology (ASOCOLPAT)

22-26 Aug 2022

ACM SIGCOMM 2022: ESR2 attended the 36th edition of the conference of the ACM Special Interest Group on Data Communication (SIGCOMM) which took place in Amsterdam.

29 Aug – 2 Sep 2022

PACE Summer School: ESR3 attended a summer school on Energy Systems to Energy Justice, organized the partners of the two projects, LUCS and PACE.

www.clarify-project.eu

3-7 Sep 2022

ESP 2022: **ESR11 attended the 34th European Congress of Pathology** which took place in Basel, Switzerland. At the event, the latest improvements in different fields of pathology, especially in digital pathology, were discussed.
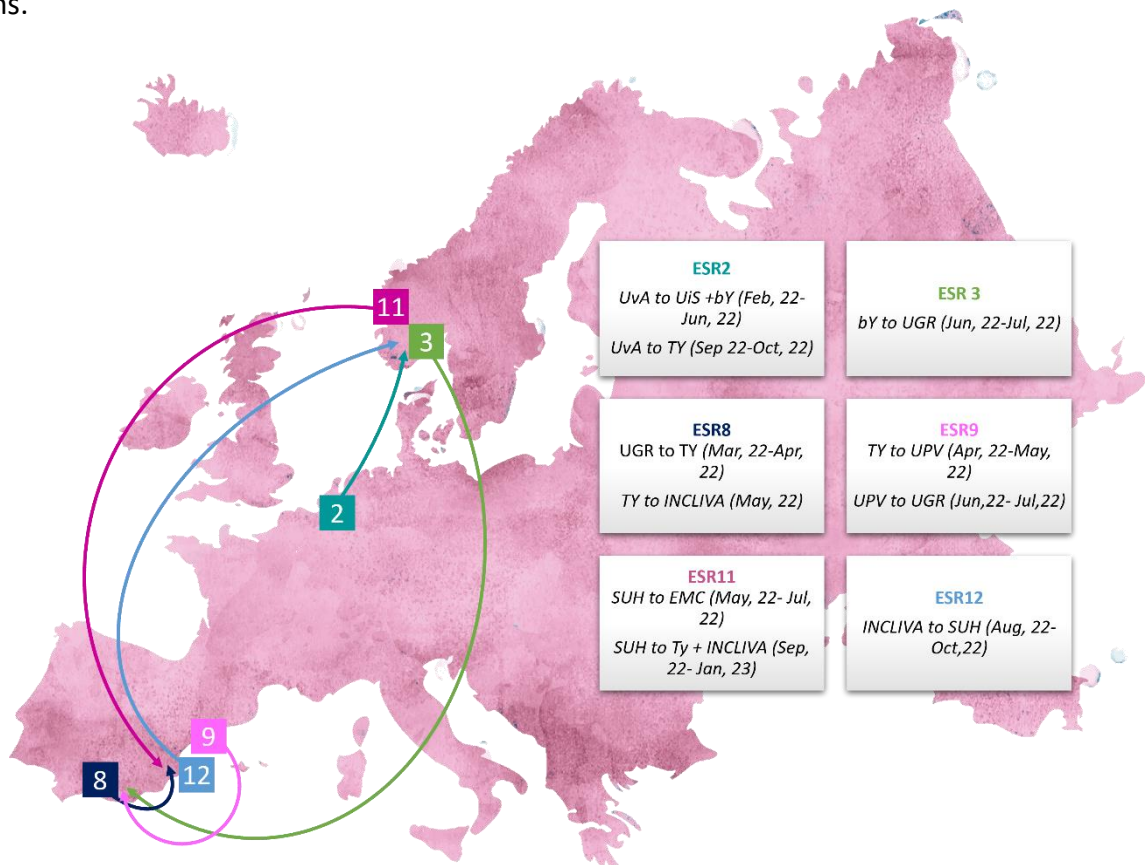
29 Sep – 1 Oct 2022

IBCN22: ESR10 attended and presented a poster titled "Dataset preparation to predict response to BCG treatment for high-risk non-muscle-invasive bladder cancer from histopathological images" in the 20th Meeting of the International Bladder Cancer Network. The event was held in Barcelona.

- **Secondments**

Since September, **6 of our 12 ESRs** have been in a secondment, someone in more than one. In total, **8 secondments** have been carried out. The other ESRs will start their secondments in the following months.

ESR2	ESR 3
UvA to UiS +bY (Feb, 22-Jun, 22)	bY to UGR (Jun, 22-Jul, 22)
UvA to TY (Sep 22-Oct, 22)	

ESR8	ESR9
UGR to TY (Mar, 22-Apr, 22)	TY to UPV (Apr, 22-May, 22)
TY to INCLIVA (May, 22)	UPV to UGR (Jun,22- Jul,22)

ESR11	ESR12
SUH to EMC (May, 22- Jul, 22)	INCLIVA to SUH (Aug, 22-Oct,22)
SUH to Ty + INCLIVA (Sep, 22- Jan, 23)	

www.clarify-project.eu

European Commission

Host Entity:	Host Supervisor:	Period of secondment:	ESR:
Univertity of Stavanger	Kjersti Engan and Chunming Rong	Febrero - Abril 2022	**ESR2**

During the secondment period from in BMDLab (i.e., Biomedical data analysis laboratory) at UiS, ESR2 has attended several academic activities, such as regular technical talks, meetings, lectures, and discussions, organized by the host. By discussing with experts in UiS, they shared with a lot of ideas and concluded an overall pipeline about developing WSI analysis.

Also, ESR2 was happy to join their social events. Thanks to the secondment, ESR2 got to know better about ESRs 3, 4, and 5, which builds a bridge not only for collaboration work but also for friendships

Host Entity:	Host Supervisor:	Period of secondment:	ESR:
University of Granada	Rafael Molina	Octover - November 2022	**ESR3**

During his secondment at UGR, ESR3 learned a lot about Deep Gaussian Processes under the guidance of Professor Rafael Molina, who introduced him the application of Gaussian method in federated learning. Also, he had the opportunity to know more about the research of the ESR8, who explained him the knowledge of Deep Gaussian Process. In addition, at the UGR he also coincided with ESR9, so he was able to learn more about her research project.

Host Entity:	Host Supervisors:	Period of secondment:	ESR:
Tyris and INCLIVA	Javier Oliver and Carlos Monteagudo	March - May 2022	**ESR8**

In his last secondments in Valencia, ESR8 had the opportunity learn more about the work developed in Tyris and INCLIVA. At Tyris, his secondment was focused on practical software engineering, interfaces and MLOps. Also, he has the opportunity to learn more about the scientific work of ESR9.

Regarding his secondment at INCLIVA, this allowed him to learn more about the histopathology. With the help of ESR12, ESR8 was able to get a close look at the WSI preparation process, as well as understand the problems pathologists face on a day-to-day basis, understanding firsthand how AI can help them.

www.clarify-project.eu

European Commission

Host Entity:	Host Supervisors:	Period of secondment:	ESR:
University of Granada	Rafael Molina	June - July 2022	**ESR9**

The main goal of this seconmdent was to analyze the impacts of color normalization on the results of Content-Based Image Retrieval (CBIR) which was completely achieved. During her secondment, ESR9 was able to collaborate with UGR researchers who are experts in the field of CBIR, and share experiences with them. In addition, during her stay at the UGR she was able to learn more about ESR8 research, as well as ESR3, who was also on a secondment at UGR.

Host Entity:	Host Supervisors:	Period of secondment:	ESR:
Erasmus MC	Tahlita Ziuverloon	May - July 2022	**ESR11**

During the secondment, ESR11 worked in collaboration with ESR10. They shared their knowledge about non-muscle invasive bladder cancer which is the project of ESR10. She attended daily morning training meetings in the pathology department at EMC, and twice a week she had a meeting with uropathologist. This period was an opportunity to see difficult, rare cases and to improve her uropathology knowledge. At the same time, ESR11 attended the regular technical meetings, experimental uropathology research group meetings and journal club hours. Seeing other research centers was a good experience for her project

Host Entity:	Host Supervisors:	Period of secondment:	ESR:
Helse Stavanger HF	Emiel Janssen	September – October 2022	**ESR12**

In this secondment, ESR12 had the opportunity to have a close approach to molecular pathology. First, knowing the equipment used in the SUH for clinical and research molecular biology and having personal sessions with the molecular biologists that work in the laboratory with a particular emphasis on New Generation Sequencing (NGS) and Fluorescence In Situ Hybridization methods. Also, ESR12 had the opportunity to participate in a National NGS workshop held in the SUH facilities. Additionally, ESR12 reviewed more than 400 slides of melanocytic tumors from the SUH´s pathology department to select and gather atypical Spitz tumors and conventional melanomas with the corresponding database.

www.clarify-project.eu

European Commission

Upcoming events

3rd training school in Amsterdam!

The **third CLARIFY Training school** organized by the Universiteit van Amsterdam (UvA) will be held in April 2023.

Technical lectures 3 on "Cloud theory and applications", Worshop III on "Career Management" and Seminar III on "Standardisation, certification and regulation of devices" will take place during those days

European Commission