3-i ICT – 1st call

PhD projects

1 About 3-i ICT PhD projects

All PhD projects will have a **supervision team** that will comprise:

- A main supervisor: a CITIC researchers qualified to guide a PhD thesis trough to completion and provide the candidate with training and support of the highest standard.
- A secondary supervisor: an experienced researcher from other academic discipline, from any national or international academic institution, research organisation or private company.
- A non-academic supervisor to monitor intersectoral secondments and help prepare the candidate for life outside the academia.

Applicants can choose up to 4 PhD projects from the 10 offered in the 1st call for candidates.

There are five thematic External Panels, each of them related to one of the five research areas of CITIC. Each PhD project is related to one of these five research areas:

- **Artificial intelligence** is mainly focused on designing and programming machines capable of performing tasks that require intelligence, with a wide range of crosswise applications in other fields.
- **Data science and engineering** are inherently multidisciplinary fields, with growing relevance in the big data era and interactions with several scientific disciplines.
- **High performance computing** is an essential tool for processing the large data sets needed to understand and meet social, scientific, and industrial challenges across a wide range of fields.
- **Intelligent Networks and Services** is a highly transferable, intersectoral area, especially in the field of Industry 4.0.
- **Cybersecurity** is a cross-disciplinary field that draws on and feeds into the other key areas of research at CITIC, including data processing and management, artificial intelligence systems, computation systems, and online services and communications.

CODE	Title	CITIC RESEARCH AREA EXTERNAL PANEL	INTERDISICIPLINARY RESEARCH AREA
2022-C1-001	Addressing challenging optimization problems in cell signalling networks with High Performance Computing and Cloud-based approaches	High Performance Computing	Biochemistry and molecular biology
2022-C1-002	Modelling complex biological phenomena via inverse optimal control and inverse reinforcement learning	Data Science and Engineering	Chemical engineering Biochemistry and Molecular Biology
2022-C1-003	Distributed and parallel algorithms for inference of cell lineage trees	High Performance Computing	Genetics
2022-C1-004	Linking Linguistics to Low-resource NLP Neural Models	Artificial Intelligence	General Linguistics
2022-C1-005	Sequence Labelling Parsing for Applied Natural Language Processing	Artificial Intelligence	General Linguistics
2022-C1-006	New microbiomics algorithms and data analytics in colorectal cancer	Data Science and Engineering	Microbiology
2022-C1-007	Automatic animal behavior analysis from video data	Artificial Intelligence	Ecology
2022-C1-008	Advances on Age-related Macular Degeneration treatment response prediction by means of ocular preclinical image analysis	Artificial Intelligence	Pharmacology
2022-C1-009	Wireless virtual sensing for control applications	Intelligence Services and Networks	Mechanical Engineering
2022-C1-010	Flexible cure models in data science to predict sustained remission in rheumatoid arthritis	Data Science and Engineering	Medicine

2 PhD projects description

CODE	2022-C1-001
Title	Addressing challenging optimization problems in cell signalling networks with High Performance Computing and Cloud-based approaches
CITIC supervisor	Dra. Patricia González Gómez https://pdi.udc.es/en/File/Pdi/Z399E
Research lines	High Performance Computing / Biochemistry and Molecular Biology
Secondary supervisor	Dr. Julio Sáez Rodríguez Institute for Computational Biomedicine, Heidelberg University
Academic PhD programme	Information technology research https://estudos.udc.es/en/study/start/5023V01
Summary	Computational models have become very popular to analyze the functioning of complex biochemical networks such as those involved in cell signaling networks. Successful models build predictive logic models of signaling pathways by training a prior knowledge network to biochemical data obtained from perturbation experiments. This training shows up as an optimization problem that require efficient and robust solution methods. The use of High-Performance Computing (HPC) techniques may represent an effective strategy to speed up the time-to-solution. However, most of these methods, handled as algorithms, may have limited parallelism, while if they are tackled as problem solving methods, they offer other opportunities for large-scale parallel computing. In this project we will explore the use of HPC and Cloud-based techniques in the context of multimethod global optimization, in which multiple different search algorithms are performed concurrently and cooperate between them through information exchange. These algorithms will also be adapted to the specific problem structure of training models of signaling networks. To address this challenge, it is required to combine the complementary knowledge in the research areas of both supervisors of the Ph.D. project. This research will be addressed in a context of an already established international collaboration, having also in mind the potential technology transfer of the research results. More precisely, the methods developed here can be used in the pharmaceutical industry to construct signaling networks of diseases and use these models to find new targets for therapy as well as to better characterize the effect of existing drugs.
Foreseen secondments	Two research visits of at least three months each to the Institute for Computational Biomedicine. In addition, possible visits to IIM-CSIC (Marine Research Institute of the Spanish Council for Scientific Research), startups such as ProtAvio (https://www.multiplex-assays.com/) and Insilico Biotechnology (https://www.insilico-biotechnology.com/) could be carried out.

CODE	2022-C1-002
Title	Modelling complex biological phenomena via inverse optimal control and inverse reinforcement learning
CITIC supervisor	Dr. Carlos Vázquez Cendón https://pdi.udc.es/en/File/Pdi/DB58E
Research lines	Applied mathematics / Chemical engineering / Biochemistry and Molecular Biology
Secondary supervisor	Dr. Julio Rodríguez Banga Marine Research Institute – Spanish National Research Council (IIM-CSIC)
Academic PhD programme	Mathematical modelling and numerical simulation in engineering and applied sciences https://estudos.udc.es/en/study/start/5026V01
Summary	In recent years, the areas of molecular biology and biochemistry are witnessing a "data-deluge" due to major technological advances in genomics, proteomics and metabolomics. However, systematic analysis of these huge new experimental data sets from a mechanistic point of view remains an open question. In this thesis, we will develop novel methods to identify optimality principles from data in order to reverse engineer complex biological systems. In particular, these methods will be used to generate mechanistic understanding of the dynamics of biochemical pathways at the cellular level. The main idea is to bridge concepts and methods from numerical and mathematical optimization (inverse optimal control) and artificial intelligence (inverse reinforcement learning) to facilitate the dynamic modelling of these biological systems. These methods will be used to automatically infer the optimality principles that can explain the observed dynamic behaviour. The research will require tight interdisciplinary collaboration (involving the areas of applied mathematics, optimization, machine learning and cellular biology) to develop and apply novel methods and tools to fundamental problems in computational systems biology. These developments will be tested with case studies involving the metabolic response of microorganisms and human cells to environmental changes. As a result, a better mechanistic understanding of these bio-systems will be achieved. This new knowledge can have a major societal impact, improving intervention strategies in biomedicine (e.g. human metabolism and cancer) and industrial biotechnology (e.g. microbial fermentation bioprocesses).
Foreseen secondments	For this PhD project, the supervisors have carefully designed a list of high-quality international and intersectoral secondments tailored to complement different aspects of the research plan. In particular, research stays have been jointly agreed at the following research groups: - Mathematical Algorithmic Optimization group, leaded by Prof. Sebastian Sager (Otto-von-Guericke University Magdeburg, Germany), world-class researcher in optimal control theory and methods (more information at https://mathopt.de/). - Microcosme group at INRIA Grenoble (France), where Prof. Hidde de Jong is a leader in computational systems biology of microorganisms and its applications in industrial biotechnology (more information at https://team.inria.fr/microcosme/). - Systems and Data Analysis group at Fraunhofer-Chalmers Research Centre for Industrial Mathematics (Gothenburg, Sweden), leaded by Prof. Mats Jirstrand (Goteborg), a top-class group developing computational tools and techniques (including machine learning) for systems and data

CODE	2022-C1-003
Title	Distributed and parallel algorithms for inference of cell lineage trees
CITIC supervisor	Dr. Diego Darriba López https://pdi.udc.es/en/File/Pdi/4Y4NH
Research lines	High Performance Computing / Genetics
Secondary supervisor	Dr. David Posada González Universidade de Vigo
Academic PhD programme	Information technology research https://estudos.udc.es/en/study/start/5023V01
Summary	Recent advances in DNA/RNA sequencing technologies have allowed the generation of genomic data at single-cell resolution, promoting an unprecedented opportunity to better understand how somatic evolution works within our bodies and the evolutionary mechanisms behind diseases like cancer. Reconstructing cell lineage trees is essential to achieve this goal, but current algorithmic approaches have shortcomings: they cannot handle large data sets and/or they use simplistic models of somatic evolution. The aim of this project is to overcome the limitations of methods for inferring cell genealogies by developing new algorithms, tools and more biologically-realistic models. The massive amount of data currently generated thanks to Next-Generation Sequencing technologies brings up the importance of using High-Performance Computing techniques and environments. The results of this project will be publicly available as Open Access publications and Open Source software and will help researchers worldwide by increasing the power of hypothesis testing in the field of single-cell phylogenetics, thus increasing the knowledge about somatic evolution and its effects.
Foreseen secondments	**Torusware** is a technology company, spin-off of the Computer Architecture Group of the University of A Coruña, and it is specialized in Big Data and DevOps services. Collaborating with Torusware is interesting because of two aspects: on the one hand it may help provide additional parallel approaches, capable of handling larger data sets. On the other hand, their DevOps experience may help during the development and release of software to increase its scope (e.g., making it available to more platforms). The **Computational Molecular Evolution** (CME) research group belongs to the **Heidelberg Institute of Theoretical Studies** (H-ITS), a private, non-profit research institute in Germany. CME focuses on large-scale evolutionary biology data analysis and High-Performance Computing. Their experience in these fields can be extremely helpful for the development of this project.

CODE	2022-C1-004
Title	Linking Linguistics to Low-resource NLP Neural Models
CITIC supervisor	Dr. David Vilares Calvo https://pdi.udc.es/en/File/Pdi/UX4BF
Research lines	Computational Science and Artificial Intelligence / General Linguistics
Secondary supervisor	Dr. Marcos García González Universidade de Santiago de Compostela
Academic PhD programme	Computational science https://estudos.udc.es/en/study/start/5009V01
Summary	Neural networks and contextualized word vectors are leading the advances for most of natural language processing (NLP) tasks, such as machine translation, question answering and information extraction. Still, these methods are often data-hungry, requiring vast amounts of data to be trained. Therefore, its effectiveness is limited in practice to a few rich-resource languages, with a prevalence of English. These issues have been exacerbated even more in the era of large language models, which are extensively demanded both in academia and industry. This leaves out of the language technology democratization process thousands of languages and billions of speakers. In this context, low-resource modelling is referred as one of the main open problems in NLP. Yet, there is little understanding on how to exploit linguistic factors as an alternative to boost the performance, under the assumption of data-scarce scenarios, and how to use them to create better technologies. The cornerstone of this thesis is to explore and improve neural models for general-purpose NLP technologies, with linguistics involved in the loop. More particularly, we will explore three research lines: (i) explaining linguistics factors that might be playing a role in the deficient performance of existing neural models for certain languages, (ii) designing linguistically-motivated methods to improve the performance of large language models for low-resource models, and (iii) explore data-augmentation approaches for supervised downstream NLP tasks that lack of annotated data. Overall, this project will contribute to develop better multilingual technologies and help democratize the access to these tools by minority populations.
Foreseen secondments	The selected applicant will be encouraged to do from 1 to 3 international stays (of approximately three months each) and we will help them to find the most suitable host. Some possible collaborators are: − University of Copenhagen (2nd best ranked NLP group in Europe) and their group, Core Natural Language Processing led by Anders Søgaard. − Yulan He, Turing AI Fellow from Warwick University, working on unsupervised machine learning. − Aline Villavicencio, Chair of NLP of the University of Sheffield, and Program Chair of ACL 2022.

CODE	2022-C1-005
Title	Sequence Labelling Parsing for Applied Natural Language Processing
CITIC supervisor	Dr. Carlos Gómez Rodríguez https://pdi.udc.es/en/File/Pdi/ZU9BH
Research lines	Computational Science and Artificial Intelligence / General Linguistics
Secondary supervisor	Dra. Margarita Alonso Ramos Universidade da Coruña – https://pdi.udc.es/es/File/Pdi/HF9AF
Academic PhD programme	Computational science https://estudos.udc.es/en/study/start/5009V01
Summary	Syntactic parsing, the process of automatically obtaining the internal structure of a sentence, is a key task for natural language processing (NLP) applications that benefit from extracting meaning from texts. Unfortunately, its potential has so far been underutilized, to a large extent because until recently, parsing algorithms were slow, ad hoc and difficult to integrate into downstream NLP tasks. However, the recent breakthrough of reducing syntactic parsing to a sequence labelling task is beginning to produce very efficient parsing models that provide their output as a sequence of discrete tags, opening possibilities for integration with other models. The objective of this thesis is to exploit this potential by exploring how sequence labelling parsing can be used to improve practical NLP tasks in large-scale setups. In this line, we will explore different means of integrating information from both constituency parsing and dependency parsing into downstream tasks like named entity recognition, aspect-based sentiment analysis or text summarization. These will include using parsing information as tag features and designing multitask learning architectures to perform parsing and the downstream tasks jointly, and will involve adapting the encodings and representations used by all involved tasks in such a way to make the integration of linguistic information as effective as possible. In addition, we will extend the results to more advanced parsing formalisms, such as semantic parsing, that can provide extra useful information. The end goal is to improve the accuracy and quality of downstream NLP tasks using linguistic information, without a significant cost to efficiency.
Foreseen secondments	We have we have regular contact with several companies, mainly Galician or Spanish (Classora Technologies, Imaxin Software, NLPgo, Zendal, MeaningCloud, or the DataLife Digital Innovation Hub) but also international (Proxem), within the framework of a national government-funded project (SCANNER) on efficient named entity recognition; as well as a collaboration with a software company with which we have submitted a project proposal related with an industrial application of NLP (more details cannot be given at this point due to confidentiality agreements). A secondment in one of these companies would be helpful, both to improve the training of the ESR by familiarising them with industrial NLP, and to improve the project itself by keeping its goals and execution in line with the requirements that industry demands. In addition, we expect the ESR to make an international secondment at the CoAStaL group at the University of Copenhagen, one of the leading NLP groups in Europe, led by Prof. Anders Søgaard. The secondment would be centered on the application of multitask learning techniques for integrating syntactic information into downstream NLP tasks.

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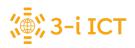| CODE	2022-C1-006
Title	New microbiomics algorithms and data analytics in colorectal cancer
CITIC supervisor	Dra. Susana Ladra González https://pdi.udc.es/en/File/Pdi/WT6MH
Research lines	Computer Languages and Systems / Microbiology
Secondary supervisor	Dra. Margarita Poza Domínguez Galician Health Service
Academic PhD programme	Computational science https://estudos.udc.es/en/study/start/5009V01
Summary	Colorectal cancer is the third most common cancer diagnosed worldwide and the first in Spain. Risk factors, such as diet or lifestyle, have a great influence on the microbiota, which is the set of microbial species that inhabit our organism. It has recently been determined that the role of microbiome in the development and evolution of pathologies such as cancer is greater than previously established. Also, it has been described that microbiome is capable of modulating the efficacy and side effects of a drug, such as chemotherapy or immunotherapy. Therefore, the motivation of this work is to identify the beneficial and harmful bacterial populations (biomarkers) present in the gastrointestinal cavity that affect the development and treatment of colorectal cancer, with the aim of promoting prevention as well as personalised therapies. In this thesis, new bioinformatics tools and algorithms will be developed for the management and analysis of heterogeneous samples and clinical data to study the role of microbiome in the development and treatment of colorectal cancer, covering all the steps of the pipeline. Different samples (faecal, oral and tissue samples, including paraffin samples) from patients and healthy relatives will be analysed using metagenomic, whole-genome or target-gene sequencing. For paraffin embedding tissue samples, new tools will be developed to address the highly degraded nucleic acids. The obtained results will be further analysed to compare the presence (or non-presence) of different microorganisms throughout the evolution of the disease (including response
Foreseen secondments	We planned a 3-month stay at the Department of Computer Science of the University of Helsinki in the second year of the PhD thesis. This will allow the PhD candidate to acquire advanced skills on bioinformatics algorithms. In particular, the research stay will be supervised by Leena Salmela, who is a collaborator of Susana Ladra. We planned one 3-month secondment to IGA Technology Services Srl (IGATEch) during the third year of the PhD thesis for the PhD candidate, such that he/she can acquire both the skills and the knowledge from this different non-academic environment. IGATech is an Italian SME and is the largest lab in Italy offering genomic research services on a wide range of organisms, from humans and other animals, to plants and microorganisms. Other international secondments can be planned to institutions that have been partners in the H2020 MSCA RISE project led by Susana Ladra in Bioinformatics and Information Retrieval Data Structures Analysis and Design (BIRDS), including the University of Chile or University of Melbourne.

CODE	2022-C1-007
Title	Automatic animal behavior analysis from video data
CITIC supervisor	Dr. Álvaro Rodríguez Tajes https://pdi.udc.es/en/File/Pdi/TX3BH
Research lines	Computational Science and Artificial Intelligence / Ecology
Secondary supervisor	Dr. Cristiano Venícius de Matos Araújo ICMAN – Institute of Marine Sciences of Andalusia – Spanish National Research Council
Academic PhD programme	Information and communications technology https://estudos.udc.es/en/study/start/5032V01
Summary	Study of animal behavior in laboratory experiments is a key factor in ethology, ecotoxicology, drug discovery, drug testing, neuroscience and other fields. These experiments are of major importance to assess animal health and wellbeing in nature and in human facilities such as fish farms and can tell us how climate change and human pollution affect animal species. The main objective of this PhD will be to develop a solution based on Computer Vision and Machine Learning, to model and extract complex behavioral traits from video recordings of animals in laboratory experiments. This PhD will expand on the previous findings of a collaboration between Umeå University (Sweden) and The University of A Coruña (Spain), resulting in the most versatile and used animal tracking solution in the world. From this framework, we will address the current limitations on the field by using Computer Vision algorithms to improve detection and tracking, Deep Learning models to identify multiple animals in social experiments, and Machine Learning models to detect high-level behaviors from tracking data. By achieving this outcome, we will be pioneering the field of behavioral computation analysis. To achieve this goal, we will collaborate with the Animal Learning and Behavior Laboratory (Distance University UNED, Spain), and the Institute of Marine Sciences of Andalusia (National Research Council CSIC, Spain), the Biophysics and Biophotonics group of the Dept. of Physics (Umeå University, Sweden), and the Dept. of Wildlife, Fish and Environmental Studies (SLU Umeå, Sweden).
Foreseen secondments	The student will perform a 3 months research stay in the Biophysics and Biophotonics group, from the Department of Physics; and The Dept. of Wildlife, Fish and Environmental Studies from Umeå, Sweden. This partner was a member of the original Toxtrac project. They will provide image datasets from experiments with fish and insects and assist with the definition of behavioral traits.

CODE	2022-C1-008
Title	Advances on Age-related Macular Degeneration treatment response prediction by means of ocular preclinical image analysis
CITIC supervisor	Dr. Marcos Ortega Hortas https://pdi.udc.es/en/File/Pdi/ML53G
Research lines	Computational Science and Artificial Intelligence / Pharmacology
Secondary supervisor	Dr. Anxo Fernández Ferreiro Galician Health Service
Academic PhD programme	Computational science https://estudos.udc.es/en/study/start/5009V01
Summary	Age-related Macular Degeneration (AMD) is a disease with a high prevalence in modern society and expected to increase due to population aging. Being the main cause of blindness among adult citizens in the EU, it greatly diminishes patient capabilities yielding comorbility. Also, it seriously damages life quality of the patient having a deeper impact, as stated by the own patients perception, than other serious pathologies such as acute myocardial infarction, cerebrovascular diseases or AIDS implying a great self-esteem loss and isolation. There is a variant of the disease called wet AMD generally caused by abnormal blood vessels that leak fluid or blood into the macula. Anti-VEGF treatments are a group of medicines which reduce new blood vessel growth (neovascularisation) or oedema (swelling) and are indicated for AMD treatment. These medicines are antiangiogenics supplied by intravitreal injections which have a high cost. The response of the patient to this treatment can be total, partial or none depending on numerous variables that make currently impossible to predict treatment response. AMD in its different forms can be assessed using retinal imaging, being Optical Coherence Tomography (OCT) one of the most used nowadays as it allows to evaluate thickness of different retinal layers associated to AMD. In this proposal, the aim is to use OCT preclinical images for automatic extraction of anatomic variables of the retina in order to develop a machine learning model for treatment response stratification based on the extracted variables.
Foreseen secondments	Regular visits to the hospital are expected for meetings with the supervisor and his team. This interaction with the health sector will provide a unique and first-hand experience to the PhD candidate who will be able to learn to propose and successfully develop research activities in the sector. It is planned to do an international secondment at the INESC TEC in Porto under supervision of Prof. Jaime Cardoso alo Professor in University of Porto. As an institution operating at the interface of the academic and business worlds, bringing closer together academia, companies, public administration, and society, INESC TEC typically applies the knowledge and results generated as part of its research in technology transfer projects, seeking value creation and immediate social relevance.

CODE	2022-C1-009
Title	Wireless virtual sensing for control applications
CITIC supervisor	Dr. Luis Castedo Ribas https://pdi.udc.es/en/File/Pdi/J729E
Research lines	Signal theory and communications / Mechanical Engineering
Secondary supervisor	Dr. Francisco Javier Cuadrado Aranda Universidade da Coruña – https://pdi.udc.es/es/File/Pdi/DF59E
Academic PhD programme	Information technology and mobile network communication https://estudos.udc.es/en/study/start/5029V01
Summary	Virtual sensing is an advanced sensing paradigm that combines real sensors with models to produce estimates of magnitudes that cannot be sensed directly. Virtual sensing is an active area of research in mechanical engineering as it enables high performance control systems. The applicability of virtual sensing, however, is still severely restricted to the consideration of only a few sensors and simple but inaccurate models due to the real-time performance limitations of the on-board hardware elements where virtual sensors are embedded. In this PhD project we propose to overcome current VS bottleneck by introducing the innovative concept of wireless virtual sensing. The idea is to leverage the extraordinary recent advances in wireless vehicular connectivity and edge computing to develop a wireless network infrastructure suitable for virtual sensing. Major work in this thesis will focus on the design of this specific wireless network infrastructure and on the optimization of its transmission and computing resources to effectively carry out the following actions: (i) real-time collection and uploading of sensor data from individual vehicles, (ii) consideration of VS models with unprecedented complexity and accuracy, (iii) seamlessly integration of side information coming from the environment and other vehicles to enable cooperative VS strategies, (iv) real-time delivering of actuating data meeting ultra-reliable and low latency requirements. This project is strongly interdisciplinary as it shares concepts, methods and technologies mainly from the areas of mechanical engineering and wireless communications engineering. The results will be useful in many different sectors like automotive industry, ICT and smart industry.
Foreseen secondments	Intersectoral secondments: - **Navantia**. Both GTEC and LIM have participated in the UMI Navantia-UDC recently finished. Negotiations are now well advanced for a new phase of the UMI that will start in 2022 and will support the work in this PhD project. - **CAF Signalling** (CAFS) is a Spanish company working on railway signalling. The PhD student will be encouraged to spend short stays at foreign research institutions to complement their training and allow his/her doctoral thesis to receive the international mention distinction (e.g. Technical University of Munich (TUM). Prof. Wolfgang Utschick; Technical University of Vienna (TUW), Prof. Markus Rupp; Tongji University, Shanghai, Prof. José Rodríguez-Piñeiro; Universitá degli Studi di Padova. Prof. Alberto Trevisani).

CODE	2022-C1-010
Title	Flexible cure models in data science to predict sustained remission in rheumatoid arthritis
CITIC supervisor	Dr. Ricardo Cao Abad https://pdi.udc.es/en/File/Pdi/2X29E
Research lines	Statistics and Operations Research / Medicine
Secondary supervisor	Dr. Francisco Javier Blanco García Galician Health Service
Academic PhD programme	Statistics and operations research https://estudos.udc.es/en/study/start/5017V01
Summary	Reliable assessment of remission is important for the optimal management of rheumatoid arthritis (RA) patients. The search of biomarkers able to predict response to treatment in Rheumatoid Arthritis (RA) has been very fruitful. Many studies with different approaches (genetic, immunologic, proteomic, functional genomics) found biomarkers associated with response to treatment. In this sense, at least 15 single nucleotide polymorphisms (SNPs) and several proteins have been proposed as candidate genetic biomarkers associated with the therapeutic response in RA. However, these biomarkers have not been fully validated due to the lack of consistent studies. A critical type of evidence, such as the validation of this potential genetic biomarkers in randomized clinical trials (RCT), is missing. In this PhD project, flexible statistical data analysis techniques will be proposed, studied and efficiently implemented to predict remission of RA after treatment. Cure models, nonparametric and semiparametric methods for survival analysis, and functional data analysis techniques will be used to define biomarker scores for predicting point remission and sustained remission. The approach by nonparametric and semiparametric cure models will be also useful to predict the time to recurrence (latency) of those patients who did not experience sustained remission.
Foreseen secondments	The PhD student to be recruited will carry out a research stay in the Biostatistics Department of one of the following pharmaceutical companies: Pfizer, Janssen of Johnson and Johnson, Novartis, Galapagos and GSK. International stays will be planned with any of the following collaborators: - Prof. Ingrid Van Keilegom https://www.kuleuven.be/wieiswie/en/person/00062045 - Prof. Valentin Patilea https://ensai.fr/en/equipe/valentin-patilea/ - Prof. Yingwei (Paul) Peng https://www.queensu.ca/academia/pypeng/ - Prof. Martin Lotz https://www.scripps.edu/faculty/lotz/ - Prof. Rik Lories http://arthritisheal.eu/rik-lories/ - Prof. Francis Berenbaum https://www.researchgate.net/profile/Francis-Berenbaum - Prof. Floris Lafeber https://www.umcutrecht.nl/en/research/researchers/lafeber-floris-fpjg - Prof. Peter Nilsson https://www.kth.se/profile/nipe