



Trinity College Dublin

Coláiste na Tríonóide, Baile Átha Cliath

The University of Dublin

Post Title:	PhD Studentship (STEM)
Post Status:	4-year Full-time PhD Studentship
Research Group / Department / School:	FRAILMatics, Discipline of Medical Gerontology, School of Medicine, Trinity College Dublin, the University of Dublin
Location:	<ul style="list-style-type: none">- Trinity College Dublin, the University of Dublin, College Green, Dublin 2, Ireland- Mercer's Institute for Successful Ageing, St James's Hospital, Dublin 8, Ireland
Reports to:	Principal Investigator (Prof. Roman Romero-Ortuno)
Terms & Conditions:	Pro-rata stipend of €18,500 per year In addition, PhD fees will be covered by the programme
Hours of Work:	37 hours per week
Closing Date:	Until the position is filled

Required start date: 1 September 2020

Post summary

A doctoral student in STEM (Science, Technology, Engineering, Mathematics) is required to conduct and assist research at Trinity College Dublin on a new research programme called **FRAILMatics: Mathematical research and big data analytics towards the development of the next generation of transdisciplinary diagnostics for the assessment of physiological vulnerability in older adults: challenge-based disruptive technology initiative**. This research programme is funded by **Science Foundation Ireland (SFI)** under the **2018 President of Ireland Future Research Leaders Programme**, awarded to Principal Investigator [Prof. Roman Romero-Ortuno](#). The grant runs from 1 December 2019 to 30 November 2024 (60 Months). The researchers on this grant will be contracted for 4 years (**expected start date: 1 September 2020**).

Prof. Ortuno is a Clinician Scientist in Geriatric Medicine with skills and international experience in big data analytics and clinical bioinformatics collaborations. Through this SFI award, he will recruit and lead a **new transdisciplinary lab** of two experienced post-doctoral researchers (one in STEM and one in Health) and two PhD students (one in STEM and one Medical) with the overall objective to advance the **science of frailty** in older adults. This new lab will be embedded within the state-of-the-art research facilities of **The Irish Longitudinal Study on Ageing (TILDA)** in Trinity College Dublin, and the **Mercer's Institute for Successful Ageing (MISA)** in St James's Hospital, Dublin; in both locations, a **new High Performance Computing (HPC) infrastructure** will be available to the team which is also funded by the award. FRAILMatics has collaborators at the SFI-funded [ADAPT Centre](#) and the [Reilly lab](#) at the Trinity Centre for Biomedical Engineering.

The successful candidate will conduct her/his doctoral research on FRAILMatics' novel research programme on the **dynamic modelling of frailty** in older adults. She/he will work under the guidance of the postdoctoral STEM and HEALTH researchers and report to the Principal Investigator.

Background to the Post

Population ageing is one of the major challenges confronting societies. Over the next thirty years, it is estimated that the proportion of the Irish population aged over 65 will double from 11% to 22%. While this represents a success story, it also presents challenges. For example, growing numbers of older people are now undergoing invasive medical procedures.

Today, in Ireland, 1 in 6 patients aged 65 or more may experience a complication from a surgical procedure, and up to 2 in a 100 may die as a result. These significant societal and economic costs could be minimised by having accurate measures of **physiological vulnerability**. FRAILMatics will address this need by conducting a programme of research **towards a new generation of transdisciplinary diagnostics**.

In older populations, there is significant heterogeneity in **biological age**. This refers to the fact that people accumulate health problems at different rates. Older people are (independently of their **chronological age**) in a functional continuum between being fully independent and

having severe dependency. **Frailty** is the part of that continuum that goes from a subtle state of low physiological reserve (or **vulnerability**) due to more than one medical problem being simultaneously present, to a more visible state of early disability. The pre-frail state is difficult to recognise because the person can appear to be well. However, close observation will reveal mild problems in day-to-day situations that require a higher level of performance.

In a situation of acute illness or trauma (i.e. **stressor**), those who are robust will only have a mild dip in their function and will quickly recover to their pre-stress baseline. However, frail people will be more likely to decompensate and have a permanent loss of function that may result in increased care needs, or even premature death.

Currently, 13% of Irish people are aged 65 or more, and this proportion is set to increase. Using current definitions, TILDA has reported that around 10% of over 65s are frail, but many more (around 40%) are pre-frail, with the rest being non-frail. When pre-frail patients are medically assessed for surgery, they may look well but present subtle symptoms and signs; those can be easily missed because they are not defined in current perioperative guidelines and protocols. However, the problems of the pre-frail may be easier to optimise with prehabilitation strategies that increase physiological resilience. Currently, only a few specialist teams offer these services, despite geriatricians wanting to advance them. Therefore, we need reliable tools to identify early vulnerability that non-experts can use.

The current state of the art in frailty identification relies on tools such as the **frailty phenotype** (which considers the presence of exhaustion, unexplained weight loss, weakness, slowness and low physical activity) or the **frailty index** (which is based on a model of accumulation of deficits); both have been validated as predictors of adverse outcomes in epidemiological and clinical studies. Yet, the reported accuracy of these tools in real clinical settings is low (too sensitive, not specific), and hence professional medical societies cannot recommend them as substitutes for a comprehensive geriatric assessment. FRAILMatics departs from the **hypothesis** that the accuracy of these tools is low because even though they capture **dysregulation in multiple physiological systems**, they have not been researched in their ability to predict physiological changes to stressors **dynamically**.

FRAILMatics' quest is **to research and develop more accurate frailty tools that without expert input automatically identify subtle dysregulated responses to stressors across physiological systems**. For this quest, FRAILMatics will have access to population and clinical cohorts that contain a vast amount of suitable cross-sectional and longitudinal data. The population cohort will be the vast and rich data resource contained in TILDA. Later on, signals will be validated in a small (n=100) clinical cohort recruited from ambulatory care clinics at the Mercer's Institute for Successful Ageing (MISA) in St James's Hospital, Dublin.

TILDA is one of the most comprehensive research platforms in existence, nationally and internationally. With FRAILMatics, TILDA's vast data resource will be leveraged for the first time through an SFI award. TILDA is a study based on a population-representative sample of >8,000 community-dwelling individuals aged 50 or over. Each participant undergoes an interview in their home, fills in a self-completion questionnaire and is invited to undergo a detailed health assessment. Five waves of data collection are complete and the study will collect its sixth wave (i.e. its third health assessment wave) in 2020 (<https://tilda.tcd.ie/about/where-are-we-now/>). A key strength of TILDA is its longitudinal design, and detailed longitudinal health data spanning 10 years will be available to FRAILMatics' researchers. The successful candidates will join a vibrant interdisciplinary team of TILDA researchers including epidemiologists, biostatisticians, economists, social scientists, biomedical engineers and clinicians. Given the size and complexity of the TILDA data there is a team of data managers, analysts and statisticians whom FRAILMatics researchers will work closely with.

In TILDA health assessments, **computer-based neurocognitive tests** are used to measure response times and errors in tests of **sustained attention** (SART: sustained attention to response task) and **choice reaction** (CRT: choice reaction time), where participants experience the stress of time under specific test instructions involving a fine motor response. TILDA also has a vast cross-sectional and longitudinal dataset of **automatically recorded gait parameters** at the person's preferred speed, under cognitive challenges, and at maximum speed (GAITRite® system). In the clinical cohort we will also collect **three-dimensional gait analysis** with the Codamotion® system. In both cohorts, multiple cardiovascular parameters are non-invasively recorded continuously (with the Finometer®) during an **active stand test**, which challenges the ability of our body systems to compensate for a rapid change in position. We

simultaneously record brain oxygenation parameters during the active stand with the PortaLite® NIRS system.

Real time physiological measurement generates vast amounts of data. FRAILMatics will have access to big cross-sectional and longitudinal datasets of over **1 billion data points**, containing detailed dynamic physiological data across the systems and also a wide range of outcome data that can be used to train models if desired. FRAILMatics will tackle this big data challenge by embracing two complementary approaches:

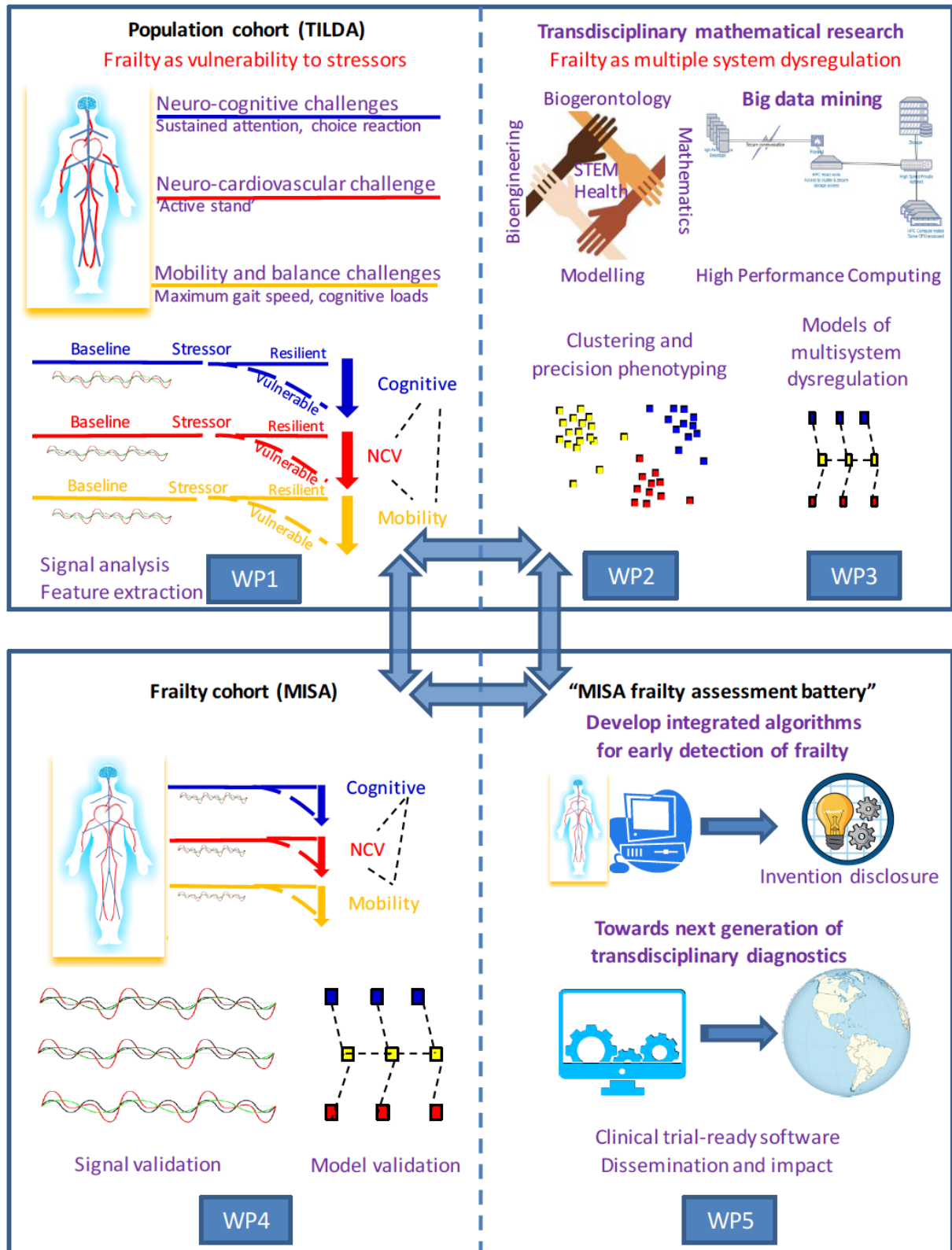
On the one hand, we will use **machine learning** that incorporates manually extracted features. For example, for the active stand we have pilot data using **information entropy**, which directly correlates with the complexity of a signal and can be measured before and after stress. We can use **multiscale entropy methods** to integrate cardiovascular signals, and signals across systems.

On the other hand, we will use **deep learning** methods where models will not be constrained by given features. For example, for the active stand we have pilot data using **Bayesian functional clustering**. These models are computationally expensive, especially if we want to cluster a large number of functional variables and variables across systems. This is why FRAILMatics requires a new start-up HPC infrastructure.

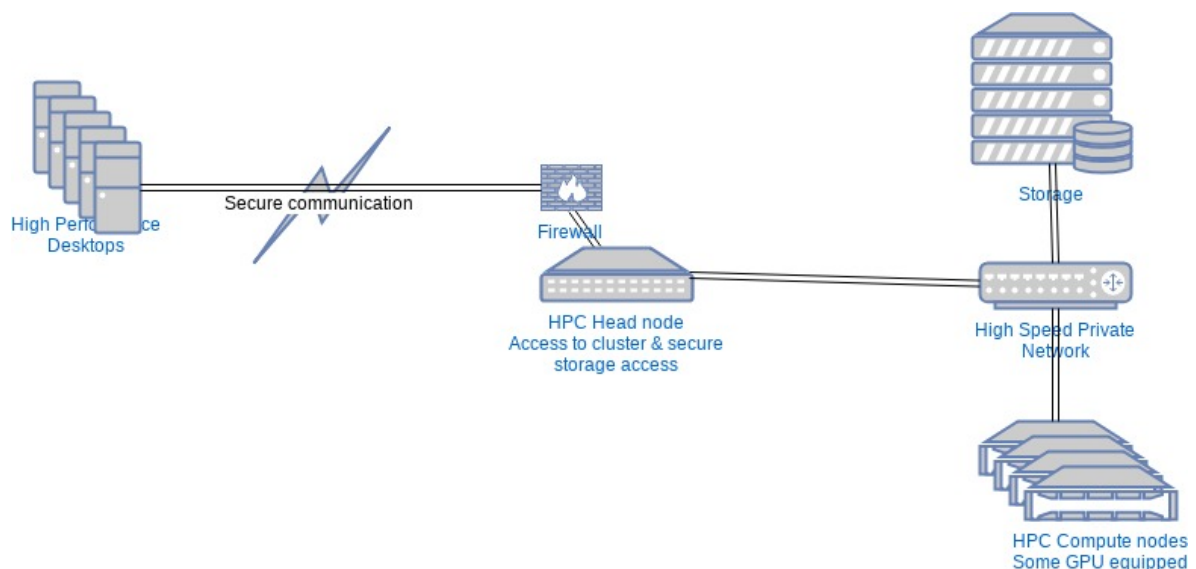
The outputs of FRAILMatics will be in the form of **new models of multiple physiological dysregulation to stressors**. FRAILMatics' ambition is to produce **software packages** that when incorporated into a brief frailty assessment battery based on existing technologies can detect and quantify patterns of vulnerability to stressors across the frailty spectrum, and therefore increase the detection of those who are at higher risk of complications with higher specificity than current frailty identification methods. FRAILMatics will advance the science of frailty and align with the Research Priority Areas in the areas of Diagnostics and Medical Devices, and also with the Sláintecare Action plan, in that savings from reducing the cost of avoidable complications could be invested in expanding new models of care based on e-health solutions. Over 5 years, FRAILMatics will generate a high volume of scientific publications and invention disclosures. At the end of the programme, FRAILMatics' tools will be at an early

stage of technology readiness, requiring new collaborations in the field of medical device trials. The summary of FRAILMatics' research programme is in the infographic below.

FRAILMatics: Mathematical research and big data learning to model physiological vulnerability and frailty in older adults



To facilitate FRAILMatics' research programme, SFI has granted the PI an infrastructure budget of circa €250,000 to purchase a new High Performance Computing (HPC) system based in TILDA. Procurement of this system is already in progress and an initial solution will be in place by September 2020, with a possibility for expansion once the successful STEM post-doc candidate is appointed. This new system will be made up of a Storage Component, a HPC Cluster (mixed CPU and GPU cluster), and a high speed network between the storage component and the HPC cluster to facilitate rapid ingress of data and output of results. The central equipment will be housed in a secure and environmentally controlled College Data Centre backed by an uninterruptable power supply, and managed by [Research IT](#) (formerly the Trinity Centre for High Performance Computing). The system will also be composed by a sufficient number of new High Performance Desktops and peripheries located in TILDA offices (in Trinity College Dublin and MISA) to facilitate development of workflows and methodologies. These computing peripheries will be managed by TILDA IT staff. An overview of this new private storage and HPC system is summarised in the Figure below.



Funding Information

This research programme is funded by **Science Foundation Ireland (SFI)** under the **2018 President of Ireland Future Research Leaders Programme**, awarded to Principal Investigator Prof. Roman Romero-Ortuno.

Further Information

Informal enquiries about this post should be made to Prof. Ortuno at romeroor@tcd.ie.

Standard Duties and Responsibilities of the Post

- Register for a PhD degree and conduct doctoral research under the direction of the Principal Investigator (Prof. Roman Romero-Ortuno) on FRAILMatics, which is the research grant from which her/his stipend will be paid. **PhD registration fees in Trinity College Dublin will be covered by the programme.**
- Assist with the management of the datasets and prepare data for machine/deep learning analyses ensuring its reliability and usability in a variety of computer programmes.
- Contribute her/his STEM expertise to perform quantitative data analyses and support the machine/deep learning processes.
- Cooperate with the TILDA management team and abide by operational policies at all times.
- Present findings to interdisciplinary audiences at seminars and conferences.
- Contribute to the organisation and running of the planned FRAILMatics' small-scale patient engagement and Patient-Public Involvement (PPI) events.
- Generate internationally peer-reviewed publications in high-impact scientific journals.

Person Specification

Qualifications

Essential

- Primary university degree in a relevant STEM (Science, Technology, Engineering, Mathematics) discipline.

Desirable

- MSc in a relevant STEM discipline.

Knowledge & Experience (Essential & Desirable)

Essential

- Good communication, writing, verbal, and organisational skills.
- Ability to work independently and effectively as a member of a team.
- Ability to communicate clearly with researchers from other research disciplines.
- Evidence of scholastic achievements.
- Willingness to learn new methods.

Desirable

- Experience in quantitative data analyses.
- Interest in health-related research.

Further Information for Applicants

URL Link to Area	www.tcd.ie
URL Link to TILDA	www.tilda.ie
URL Link to MISA	www.misa.ie

The Irish Longitudinal Study on Ageing (TILDA), Trinity College Dublin

Prof. Ortuno will lead FRAILMatics through the utilisation of the big data resource and infrastructure contained in [TILDA](http://www.tilda.ie). TILDA will provide the SFI team with strong, centralised support for research operations activities across the life cycle of the research project, and will recruit and accommodate the new STEM and biomedical staff undertaking big data mining and development of modelling tools. TILDA will also accommodate a new storage and High Performance Computing (HPC) infrastructure to facilitate the research.

TILDA is a nationally representative prospective cohort study of the social, economic and health circumstances of 8,175 people aged over 50 in Ireland, including childhood socioeconomic circumstances and events. TILDA aims to improve population health by

providing insights into potentially new modifiable risk factors that can be used in screening tests for clinical and public health practice. TILDA collates long-term comprehensive physiological data that is not available to other nationally representative samples and measures a vast number of novel objective health measures across a wide range of physiological systems, including neurocardiovascular instability (e.g. heart rate variability, pulse wave velocity, beat-to-beat orthostatic blood pressure responses), biomarkers, gait and balance signals (accelerometry and gait analysis), and neurocognitive function.

The Mercer's Institute for Successful Ageing (MISA), St James's Hospital, Dublin

[MISA](#) at St. James's Hospital is a state-of-the-art-facility for integrated clinical services and a hub for world-leading clinical services and research in ageing. The Institute promotes coordinated patient-centred care, coupled with far-reaching educational and training programmes. Responding to the need for innovation in the delivery of services for Ireland's ageing population, the Institute provides early diagnostic and rapid access care clinics, along with inpatient acute assessment, rehabilitation, and continuing care units; delivers innovative research and develops technologies with industry partners to advance healthy life-years; and serves as a local resource to the surrounding community, while offering Ireland a national centre for Successful Ageing.

In MISA, the state-of-the art **Falls and Syncope Unit** ([FASU](#)) provides rapid, expert assessment and treatment for adult patients who suffer from dizziness, faints, falls and syncope (loss of consciousness). Using state-of-the-art neuro-cardiovascular technologies, the FASU team investigates balance disorders, fluctuations in blood pressure, and changes in gait and blackouts, advancing accurate diagnoses and appropriate treatments. MISA and FASU facilities will be available to the FRAILMatics team for the translation of the TILDA-based research.

Facilities of the [Biomedical Engineering laboratory](#) at MISA will also be available to the team. The lab provides a space for engineering concepts and skills to be applied to clinical and research problems in medicine, with a particular focus on older age. The Biomedical Engineering laboratory hosts hospital personnel and visiting postdoctoral, postgraduate and

undergraduate students working on clinical projects with a technological or engineering science component. The lab hosts and maintains the 3-D gait platform, which will be available to the team for the clinical research phase of FRAILMatics, in addition to equipment to support electronic prototyping, software development, data analytics, optics development, system modelling and 3D printing.

Discipline of Medical Gerontology

Ageing is one of the principal strategic themes in Trinity College Dublin. The [Discipline of Medical Gerontology](#) supports clinical and didactic teaching and research around successful ageing and preventative care of the older person. The teaching curriculum aims to demonstrate to students that a tailored approach to the management and care of the older person is necessary to manage the problems of later life. The emphasis on prevention as well as detection and remediation of functional loss, aims to help students gain an understanding of the need for a structured approach to disease syndromes often inherent in the ageing process. The discipline is committed to improving the undergraduate training of students at Trinity College Medical School by exposing them to a holistic approach to disease management and by encouraging the management and use of multidisciplinary therapies, grounded in science and of proven efficacy. The Discipline of Medical Gerontology contributes to the undergraduate courses in Medicine, Dentistry, Occupational Therapy, Physiotherapy and Radiation Therapy.

With a long and well established history in ageing research, the Discipline of Medical Gerontology is currently involved in a diverse range of research projects. These research programmes will enable health professionals and academics to consider the full range of activities and aspects that affect and shape the ageing process as well as deliver new ways to advance the concept of successful ageing and promote preventative health care.

The Discipline's multidisciplinary and integrative approach is supported by education and training policies which focus on the social, psychological and biological aspects of ageing. The programme span a broad range of research areas including basic sciences, translational research as well as health and social policy research.

Trinity College Dublin, the University of Dublin

Trinity is Ireland's premier university, with a proud tradition of excellence stretching back to its foundation in 1592. The oldest university in Ireland, and one of the oldest in Europe, today Trinity sits at the intersection of the past and the future, and is ideally positioned as a major university in the European Union. Our 47-acre campus is located in the heart of Dublin city centre and is home to historic buildings dating from the University's establishment, as well as some of the most cutting-edge teaching and research facilities in Ireland. Students at Trinity benefit from a unique educational experience across a range of disciplines in our three faculties – Arts, Humanities, and Social Sciences; Engineering, Mathematics and Science; and Health Sciences. The pursuit of excellence through research and scholarship is at the heart of a Trinity education, and our researchers have an outstanding publication record and strong record of grant success.

Trinity has developed [18 broad-based multidisciplinary research themes](#) that cut across disciplines and facilitate world-leading research and collaboration within the University and with colleagues around the world. These internationally recognised themes include such diverse areas as Cancer, Immunology, Telecoms, Identities in Transformation, Nanoscience, Neuroscience, and Making Ireland. Researchers from across the University work together in innovative ways to develop new and exciting approaches to their research and explore the frontiers of knowledge in the 21st century. In creating these dedicated research themes, Trinity's researchers are able to become a more powerful force on the global stage, successfully competing for large-scale grants and attracting top students and faculty to the University. Trinity is home to Ireland's first purpose-built Nanoscience research institute, CRANN, which opened in January 2008. This state-of-the-art facility houses 150 scientists, technicians, and graduate students in specialised laboratories, fostering creative innovations that have seen Trinity's researchers make significant breakthroughs.

The Trinity Long Room Hub for Arts and Humanities Research Institute is the University's flagship institute for research in the Arts and Humanities, providing a world-class environment for cross-disciplinary collaborative projects. The Long Room Hub provides a central location through which the University's internationally respected Arts and Humanities research can

become more visible, demonstrating its relevance for contemporary and future societies. Researchers from across the University regularly participate in debates on topical issues facing the world today. As well as operating an International Visiting Research Fellowship programme, the Long Room Hub also hosts major EU-funded Digital Humanities projects.

One of the most instantly recognised parts of Trinity's campus is the famous Old Library, home to the historic Book of Kells as well as other internationally significant holdings in manuscripts, maps, and early printed material. Trinity's Library is the largest research library in Ireland and is an invaluable resource to Trinity's students and research community. Built up over the four centuries of the University's existence, the Library's collections have benefitted from its status as a Legal Deposit library for the past 200 years, granting Trinity the right to claim a copy of every book published in Ireland and the UK. At present, the Library's holdings span approximately 4.25 million books, 22,000 printed periodical titles, and access to 60,000 e-journals and 250,000 e-books.

Trinity attracts top students from Ireland and abroad and prides itself on the consistently high standard of student admitted to the University every year. These students are drawn to Trinity for the excellence of our research-led teaching and for the quality and prestige a degree from this University confers. Trinity has also pioneered accessibility to education in Ireland, becoming the first university in the country to reserve 15% of its undergraduate places for students from non-traditional learning groups. Trinity is the top-ranked European university for student entrepreneurship and Europe's only representative in the world's top-50 universities.

Our alumni have gone on to shape the history of Ireland and of Western Europe in a wide range of fields. These include such notable figures as Jonathan Swift, Oscar Wilde, William Rowan Hamilton, Edmund Burke, William Stokes, Denis Burkitt, Louise Richardson, Lenny Abrahamson, and Anne Enright. Three of Trinity's graduates have been awarded Nobel prizes: Ernest Walton for Physics in 1951; Samuel Beckett for Literature in 1968; and William Campbell for Physiology / Medicine in 2015. Trinity also counts the first female President of Ireland among its alumni in Mary Robinson, as well as other notable former Presidents Douglas Hyde and Mary McAleese. At Trinity we are justifiably proud of our tradition, and we strive to uphold this excellence as we face the demands of the 21st century.

Ranking Facts

Trinity is the top ranked university in Ireland. Using the QS methodology, the University is ranked 104th in the world and using the Times Higher Education World University Rankings methodology Trinity is 117th in the world.



Overall

- Trinity is Ireland's No.1 University in the QS World University Ranking, THE World University Ranking and the Academic Ranking of World Universities (Shanghai).
- Trinity is ranked 104th in the World, and 36th in Europe, in the 2018/2019 QS World University Ranking.
- Trinity is ranked in the Top 120 for Graduate Employability in the QS 2018 Rankings.
- Trinity is in the Top 50 most innovative universities in Europe according to Reuters.¹
- Between 2010 and 2015, Trinity was ranked the top university in Europe for entrepreneurship according to Pitchbook's independent analysis.²

¹ <http://www.reuters.com/article/us-innovative-stories-europe-idUSKCN0Z00CT>

² <http://pitchbook.com/news/reports/2015-2016-pitchbook-universities-report>

Internationalisation

- **Trinity is ranked 52nd in the world in the THE World University Ranking for international outlook.**

Research Performance

- **Of the 981 institutions included in the THE World University Rankings for 2017, Trinity is in the top 15% internationally for research performance.**
- **Trinity is ranked in the top 15% internationally by QS for citations.**

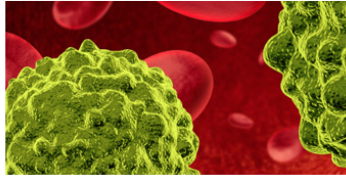
In the QS World University Subject Rankings:

- **Trinity is ranked in the top 50 worldwide in four subject areas according to the QS World University Subject Rankings 2018. The University is ranked in the top 100 globally for 20 subjects overall.**
- **Trinity's Top 50 subjects include Nursing (25th), Classics (28th), English (28th) and Politics (43rd).**
- **Trinity is ranked in the top 100 for each of the following 16 subjects: History, Languages, Philosophy, Theology, Computer Science, Biology, Medicine, Pharmacy, Chemistry, Geography, Materials Science, Education, Law, Social Policy, Sociology and Sport.**
- **The University is ranked in the top 100 for three broad subject areas: Arts & Humanities (57th), Life Sciences & Medicine (87th), and Engineering & Technology (89th).**

Research Themes



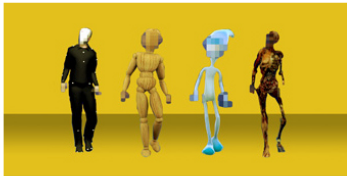
Ageing



Cancer



Creative Arts Practice



Creative Technologies



Digital Engagement



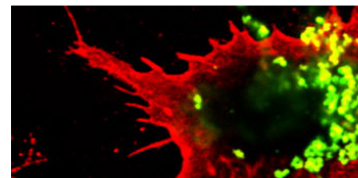
Digital Humanities



Genes & Society



Identities in Transformation



Immunology, Inflammation & Infection



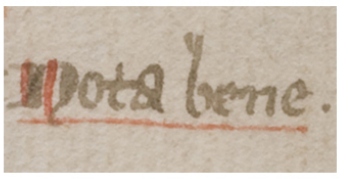
International Development



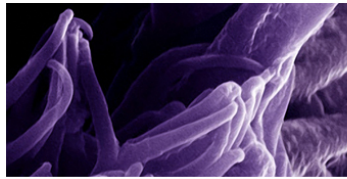
International Integration



Making Ireland



Manuscript, Book and Print Cultures



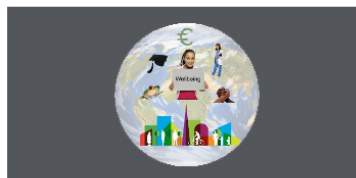
Nanoscience



Neuroscience



Telecommunications



Smart Sustainable Planet



Next Generation Medical Devices

Application Procedure

Candidates should submit a cover letter together with a full curriculum vitae to include the names and contact details of 3 referees (email addresses if possible) to:

Name: Roman Romero-Ortuno

Title: FRAILMatics Principal Investigator

Email Address: romeroor@tcd.ie



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