



The  
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Sheffield.



UK Research  
and Innovation

# UKRI Centre for Doctoral Training in Speech and Language Technologies and their Applications



**SLT**

Centre for  
Doctoral Training

**Sponsor Brochure**

# What are Speech and Language Technologies?

Since the inception of Artificial Intelligence (AI) in the 1950s, a central vision of the field has been of machines that can understand spoken and written human language.

This capability would enable natural interaction between people and computers, translation between all human languages, and tools to analyse and answer questions about vast archives of text and speech.

Speech and Language Technologies (SLTs) are a range of approaches which allow computer programs or electronic devices to analyse, produce, modify or respond to human texts and speech.

SLTs are underpinned by a number of fundamental research fields including natural language processing, computational linguistics, mathematics, machine learning, physics, psychology, computer science, acoustics, and speech processing.

In the last two decades the societal shift to digital media, coupled with spectacular advances in computer storage, processing power and software capabilities, especially in machine learning and SLTs, has meant this vision is no longer science fiction but is turning into reality.

SLTs are now established as core scientific/engineering disciplines within AI and have grown into a world-wide multi-billion dollar industry, with massive application potential (global revenues for the industry were valued at \$33bn in 2015 and predicted to rise to \$80bn by 2020, an annual average growth rate over 19%).

There is huge demand for scientists with advanced training in SLT from both large corporations and SMEs, most of whom hire only at PhD level and are in fierce, international competition to attract talent: supply is falling far short of demand.



## A PhD. With a difference.

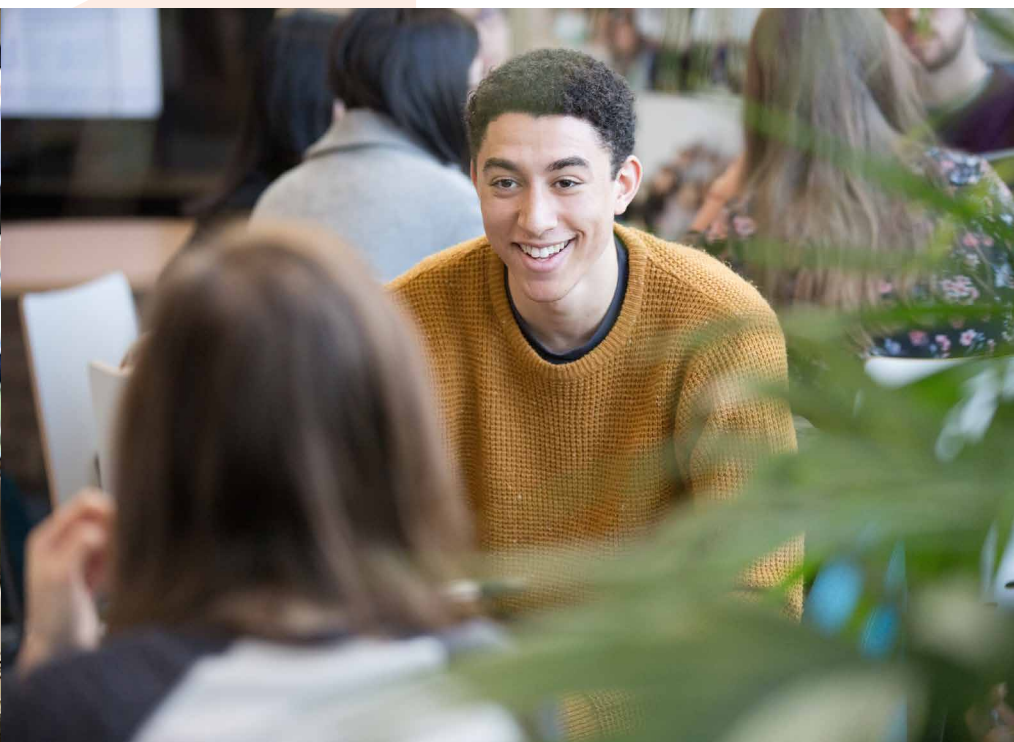
Our Centre for Doctoral Training (CDT) addresses the SLT skills gap – the first ever dedicated CDT in this area.

And it goes far beyond a 'standard' PhD.

We are both training individuals with the core technical and scientific SLT skills that industry and the UK economy demand, and embedding our CDT's students in a vibrant research centre that provides training in engineering skills, leadership, management, entrepreneurship, and responsibility to society.

Our unique PhD with integrated Postgraduate Diploma (PGDip) in SLT Leadership is a bespoke programme that will provide our students with the necessary skills for academic and industrial leadership in the field.

Furthermore, historically the individuals choosing to study Computer Science, and AI in particular, at the advanced level have been predominantly male and from majority ethnic groups. The SLT academic community is committed to attracting more women and minorities into AI and SLT research (some of these initiatives are led by our own CDT's academics). Building on these initiatives we will strive to attract a diverse set of students into the CDT.



# The Centre

Our Centre for Doctoral Training is supported by UK Research and Innovation (UKRI), the UK's national funding organisation for research.

It is hosted by the University of Sheffield's Department of Computer Science which has an international reputation for the quality of its research and teaching. In the 2014 Research Excellence Framework (REF), 92% of our research work was rated world leading (4\*) or internationally excellent (3\*) in terms of its originality, significance and rigour. We have a REF grade point average (GPA) of 3.39, ranking us 5th out of 89 computer science departments in the UK.

We are training the next generation of highly skilled researchers in SLTs to gain the skills required to successfully enter the three main areas of need for SLT experts in the UK:

1. Academia
2. Mid-to-large scale SLT R&D teams
3. Start-ups

Our students undertake high quality research that is relevant to the needs of industry alongside a comprehensive training programme addressing core and professional skills – gaining a Postgraduate Diploma (PGDip) in SLT Leadership with their PhD.

The CDT offers a unique combination of industry-driven projects covering all areas of natural language processing (NLP) and speech processing research, including natural language analysis and generation, information retrieval, text mining (including sentiment analysis), question answering, machine translation, speech and speaker recognition, diarisation, machine hearing, novel methods of interaction and dialogue, and detection and analysis of paralinguistics.

Every PhD project is underpinned by a real-world application, ideally directly supported by an industry project partner.

Students in the CDT have a far superior level of support and training to that of a 'conventional' PhD studentship. Every student receives 4 years of enhanced funding (including fees and bursary increased by approximately 25%), an increased personal research budget, specific training on core expertise, industry-led teaching, CDT-wide cross-disciplinary mini-projects, and much more.

The CDT will train 60 university-based PhD students, split into five annual cohort intakes, over a total period of 8 years. Our first cohort of students started in September 2019.

Sponsoring a student lets your company drive research in areas relevant to your needs, with access to world-class research facilities and experts in SLT.

The unique nature of the CDT means that our research students are both academically strong and highly committed to solving real-world research problems – and so are a valuable asset to your company.

## Why Now?

Artificial Intelligence (AI) is a disruptive technology and is underpinning significant change in the global economy – a trend which will continue for the foreseeable future.

Recent reports by PwC (*The macroeconomic impact of artificial intelligence* and *The economic impact of artificial intelligence on the UK economy*) predict that by 2030 AI could contribute a 14% increase to global GDP, equivalent to \$15.7 trillion. They see 70% of that additional value coming from North America and China. In the UK they predict GDP will be up to 10.3% higher in 2030 as a result of AI – the equivalent of an additional £232bn, leading Northern European economies just slightly.

To advance its position in the global AI race, the UK must invest in the primary resource needed to develop new AI technologies and enterprises: people with advanced training in AI.

Our CDT is playing a critical role in this national strategy to address the AI skills gap; SLT is particularly important for the following reasons:

1. SLT is a core area within AI because human language is absolutely central to all human social (and hence economic) activity and so the scope for application is virtually limitless (in the PwC report SLT and its applications figure centrally in their “layers” of AI).
2. SLT is an area where the UK is internationally leading, and it must invest to maintain its position, and where it benefits from the global dominance of the English language.
3. As the strong industrial support for this CDT shows, there is huge appetite within UK industry and the public sector for more skilled researchers in this area.



# The Training Programme

Every student receives training in four domains:

1. core technical knowledge
2. SLT collaborative research practice
3. research and innovation professional skills
4. personal effectiveness and leadership

Training is delivered via several modes:

- individual study
- cohort-based study
- cohort-based project work
- external activities

Research streams are topically related themes that are designed to bring together researchers from all sub-areas of SLT for discussion and collaboration. Based on their project each student engages with at least 2 streams, and each stream is led by a co-investigator of the CDT with the objective of ensuring students gain a broad knowledge and coverage of the stream subject.

Informed by real world deployment of SLTs, the streams are:

- I. SLT Frontiers - novel methods:** New machine learning and algorithmic approaches to solve SLT problems; novel interpretations of data; new methods of obtaining or characterising data.
- II. Scalable SLTs:** SLT methods that allow adjustments of methods to different task complexities; transferring SLTs as component of larger tasks; design of scaleable SLTs.
- III. Robust SLTs:** Resilience to SLT domain and data variability; methods to achieve uniform performance across diverse data; transfer learning and adaptability.
- IV. Novel SLT applications:** Pushing the boundary on where SLT can be used; methods to obtain data for new applications; approaches for transferring of existing methods.
- V. Interconnecting SLT with the world:** Approaches that connect advanced methods with real world problems; methods that allow cross-fertilisation between domains; transferable methods for SLT; methodology in approaching real world problems.

Student training is designed to be a journey that progressively expands the level of expertise in both research and professional, transferable skills. Training content is delivered in the form of credit-bearing, University-accredited modules.

The CDT demonstrates enhanced training beyond pure SLT research, via the Postgraduate Diploma (PGDip) in SLT Leadership, ensuring students obtain leadership, entrepreneurial, and software skills.

Training is tailored to each individual student's needs with individual module selection informed by the University of Sheffield Doctoral Development Programme and a training needs analysis (TNA) carried out with each new student during the first few weeks of their programme.

# The Student Journey

## Training Year 1 – Skill Foundation

SLT is exceptional in the range of disciplines which it draws upon, from linguistics and phonetics through mathematics and computer science to signal processing and electrical engineering. The first year is therefore designed to ensure that the group of students enrolling from diverse academic backgrounds can develop into a well-integrated, self-supporting cohort. Students receive unconscious bias and Equality, Diversity and Inclusivity (ED&I) training to perpetuate an environment of fairness, equality, diversity and respect. After an induction phase, student PhD projects will be defined in discussion with the students, supervisors and industrial partners.

## Training Year 2 – Scientific Foundation

The second year is devoted to developing advanced SLT research skills in practice, to perform the first foundational experiments and to formulate the plan for the PhD. The student will engage in further cohort and external activities as well as receive further training in all training domains and modes.

## Training Year 3 – Research

This is expected to be the most productive research year. Activities will be similar to those conducted in Y2, however the students are expected to perform more leadership roles in cohort and team work, e.g., by supervising mini-projects, by stepping into planning roles in the cohort-wide activities, or by mentoring of peers. Internships are likely to happen in Y2 or Y3.

## Training Year 4 – Consolidation, Presentation and Dissemination

In the final year the emphasis will be on thesis completion and on ensuring impact through presentation or realisation in practical settings. The year will see the completion of the PGDip, followed by submission and assessment of the PhD thesis.

### The cohort approach

Our CDT's students are trained using a cohort-based approach since:

1. the software infrastructure, tools and methods for SLT are highly complex and creating them is nearly always a collaborative endeavour – a cohort offers an ideal setting to gain experience of such collaborative working.
2. PhD topics tend to be narrow and focused on specifics and do not include the broad overview needed in students' later careers – through cohort training we can expose students to a range of different SLT topics.
3. peer learning within and across cohorts is a highly effective way to hand over tools and to teach methodology.
4. a multi-year cohort programme allows significant and sustained progression in larger (i.e. multi-student) SLT projects, resulting in better research outcomes and more impact in partnering companies.
5. cohort teaching is very attractive to students.
6. an extended cohort-based training programme with strong group work and peer tutoring elements allows students with non-standard backgrounds be admitted, helping to promote diversity in SLT.

# The Team

## Directors



### **Professor Thomas Hain**

*Head of Speech and Hearing Research*

World leader in speech recognition, heads the VoiceBase Centre for Speech and Language Technology, and is a leader in the speech community.

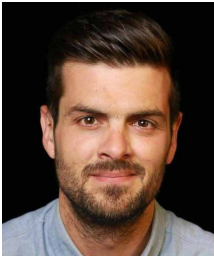


### **Professor Rob Gaizauskas**

*Natural Language Processing Research*

Internationally known for his research on information extraction and text mining, temporal information processing, question answering and summarisation.

## Theme Leads



### **Dr Nikos Aletras**

**Theme: SLT Frontiers – novel methods**

Expert in topic detection and interpretation in large volumes of text data.



### **Professor Jon Barker**

**Theme: Robust SLTs**

World leader in research into speech communication in natural environments.



### **Dr Loïc Barrault**

**Theme: Scalable SLTs**

Expert in statistical and neural machine translation including linguistics aspects (factored neural machine translation) and considering multiple modalities (multimodal neural machine translation).



### **Dr Stefan Goetze**

**Theme: Interconnecting SLT with the world**

Expert in sound processing and enhancement; assistive technologies; human-machine interaction; detection and classification of acoustic events; and automatic speech recognition.



### **Dr Heidi Christensen**

**Theme: Novel SLT applications**

Expert in a wide variety of clinical application of speech technology, spoken language processing and binaural machine listening.



# Supervisors

- **Prof Guy Brown** is world renowned for his work on Computational Auditory Scene Analysis and his research into noise robustness of speech technology and hearing impairment.
- **Prof Paul Clough** is an expert in information retrieval, specifically multilingual and geographical search, image retrieval, text re-use and plagiarism detection, and evaluation of search systems.
- **Dr Yoshi Gotoh** is an expert in interpreting speech in the context of audio visual processing, in particular, applications of speech recognition in video analysis and video information retrieval.
- **Dr Mark Hepple** is an NLP expert in many areas with specialisation in formal grammar and parsing, information extraction, temporal information processing, and robust dialogue processing.
- **Dr Chengua Lin** is an expert in the development of algorithms and models for natural language generation, sentiment analysis, text/opinion summarisation, and intention recognition for cybersecurity.
- **Dr Diana Maynard** is lead computational linguist directing the development of the GATE framework, and expert in terminology extraction and ontology development.
- **Prof Roger Moore** was president of the International Speech Communication Association (ISCA) and is a highly regarded international speaker with a keen interest in bringing SLTs to robotics.
- **Dr Anton Ragni** is an expert in kernel methods for speech processing, discriminative modelling for speech processing, and generative modelling for speech processing.
- **Dr Carolina Scarton** is an expert in text adaptation, machine translation, online misinformation detection and verification, evaluation of NLP task outputs, NLP applied to healthcare and robotics, and dialog systems.
- **Professor Lucia Specia** is an expert in machine translation (MT) and text adaptation; currently she holds an ERC fellowship to investigate the use of multi-modal, contextual information to improve MT.
- **Dr Mark Stevenson** is internationally recognised for his work in word sense disambiguation, information extraction and retrieval, plagiarism detection, lexicon adaptation, exploratory search.
- **Prof Aline Villavicencio** is an expert in computational models for languages, using a combination of machine learning and linguistic/psychological theories to tackle issues of multilinguality, including for low-resourced languages in applications such as machine translation and text simplification.

In addition, affiliate supervisors are also drawn from various associated research groups both from within the Department of Computer Science as well as other University of Sheffield departments and research institutes.

## Working with the Centre

As a potential sponsor, you can work with us to identify medium term research projects that will benefit your organisation's activities, but which also have academic depth suitable for doctorate study. You will help define the project, provide experimental data and / or access to facilities, be involved in the student's supervision via periodic progress meetings, and have the opportunity for the student to undertake an internship.

Many companies sponsor several PhD research students in the CDT as they see the real difference that the research students and their project work make to their business.

Sponsoring a PhD candidate is an ideal opportunity to propose and drive a research project tailored to your own company's development needs, with access to world class research facilities and experts in AI and SLT.

Projects receive substantial co-funding from UKRI and sponsors may also be eligible for Research and Development Tax Credits from HM Revenue & Customs. Joint industrial sponsorship is welcome where this is relevant.

The PhD research is built on the foundations of the industry sponsor's technical and commercial needs. Many research students go on to join their sponsors in key technical roles.

Both the research student and your staff will benefit from effective knowledge transfer through the CDT's activities. In addition to gaining skills and insights from your project student, their supervisory team, and the wider cohort, your staff will have the opportunity to impart industry-specific skills and insights to our students.

The PhD is a highly cost-effective way to drive relevant leading-edge research which you may not have the funding, expertise or equipment to undertake in-house.

Through the CDT, sponsors have access to world-leading expertise in AI and SLT and your organisation will be part of an extended network of like-minded organisations.

### **Intellectual Property Rights (IPR)**

The PhD project is a close partnership between the sponsor and the University, and there will be some joint outputs and publications. We can negotiate IP arrangements, and will follow a reasonable approach to publication (i.e. sponsor prior approval, removal of sensitive information, etc). You can review our standard agreement templates at any time.

# What will it cost and how do I get involved?

The sponsor company pays less than half of the cost of the four-year PhD studentship, with the remainder being provided by UKRI and The University of Sheffield.

Standard PhD with integrated PGDip in SLT cost breakdown:

- £10,000 for expenses relating to the studentship – e.g. student- and project-specific training, conference expenses, travel, safety equipment etc.
- £85,308 for enhanced student stipend (£17,000 pa) and academic fees.
- £25,000 contribution to group training activities and CDT administration.
- Total: **£120,308**

We operate a two-tier sponsorship approach:

- Tier 1 sponsors propose specific PhD projects, have significant input into their design, make their application the focus of the research, have the opportunity to host internships for the student, and have bespoke agreements for IPR. Total cost is **£46,000** for the entire 4-year studentship (just £11,500 per year).
- Tier 2 support is associated with projects with a low level of input and less claim on the student's time. Total cost is **£23,000** for the entire 4-year studentship (just £5,750 per year).

To promote cohort cohesion we apply a uniform funding model for all students (same stipend, same training budget) regardless of the sponsorship approach adopted by the industrial partner with whom they work.

In some cases, the standard package breakdown may be open to negotiation. Examples include if additional resources are needed for the experimental projects, or a sponsor wishes to top up the student stipend to attract the most talented candidates.

Sponsorship partners can further engage with the CDT through conferences and seminars, by making data available for research, by operating mini-projects, and participating in the Industrial Sponsors' Forum. Supporting a student also means you will become a member of the Centre, which will open up a wide range of other engagement opportunities with our students, researchers, academics, and the wider group of sponsoring companies.

Furthermore, since training as part of a CDT is a unique opportunity there is also the opportunity to fully fund a PhD student at a cost over 4 years of approximately £120,000 for a UK or EU student (approximately £170,000 for a non-EU/UK student). Such a student would work much more closely with your company including time at your location.

Support for the CDT in the form of teaching, bespoke hardware, software or data, supervision would also be beneficial – please get in touch. Non-student related financial contributions such as provision of travel awards, or supporting annual workshops are also very welcome.

Sponsors may also be able to claim Research and Development (R&D) Tax Credits.

To find out more about becoming a CDT partner, please contact Dr Stuart Wrigley (CDT Operations and Business Development Manager) by emailing [s.wrigley@sheffield.ac.uk](mailto:s.wrigley@sheffield.ac.uk) or calling 0114 222 1880.

# UKRI CDT in Speech and Language Technologies Partners and Affiliates



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