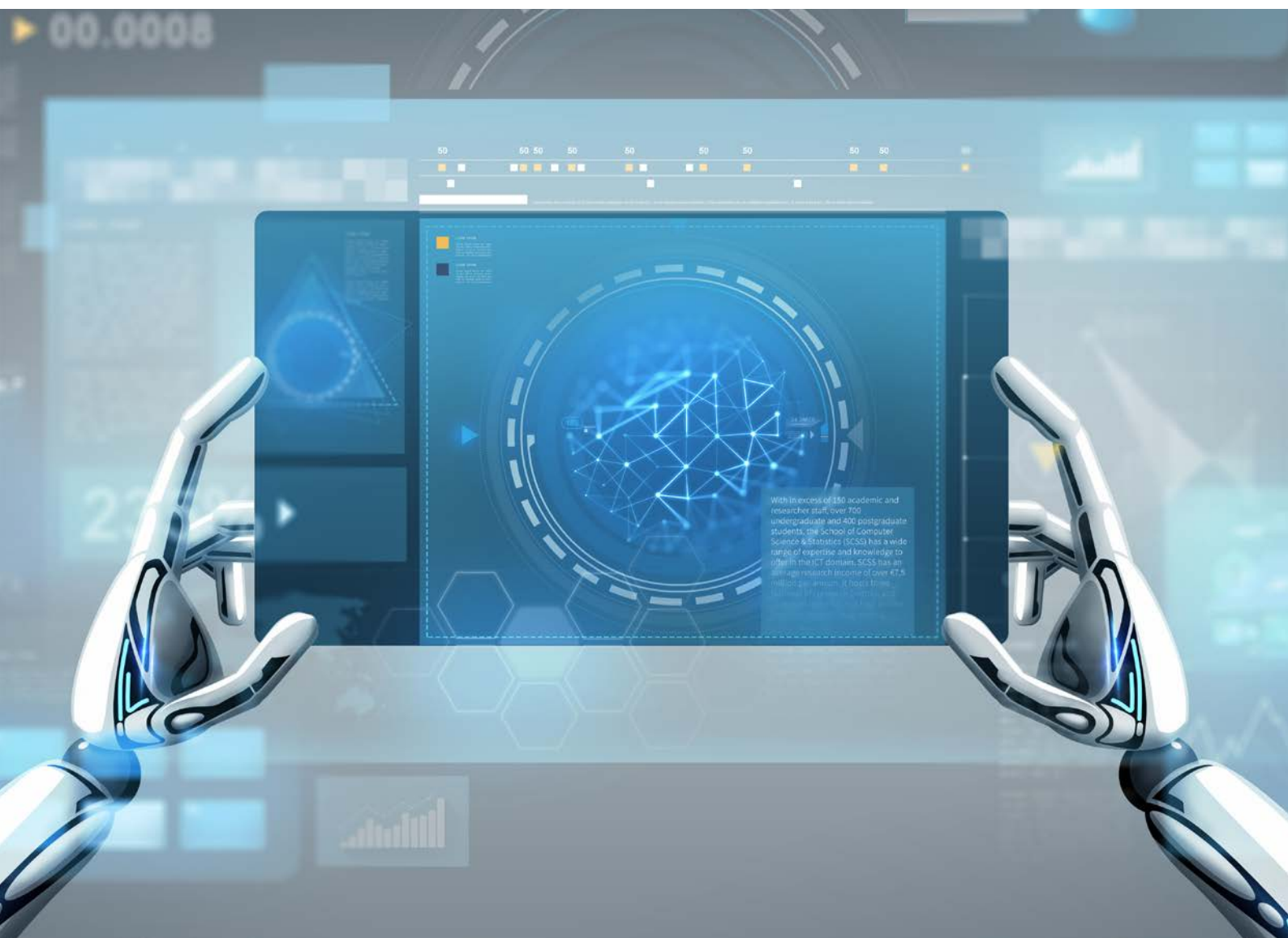


School of Computer Science & Statistics

Research Expertise for partnering with Industry



Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

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Computer Science @ Trinity:

Top 100 worldwide, Top 25 in Europe, #1 in Ireland (QS subject rankings, 2018)

The School of Computer Science & Statistics (SCSS) has over 150 academic and researcher staff, 700 undergraduate and 400 postgraduate students and a wide range of expertise and knowledge to offer in the ICT domain. **The School of Computer Science & Statistics is ranked in the top 100 CS departments in the world** (source QS 2018 University rankings).

Working with industry and the business community, our aim is to develop partnerships that enable industry to benefit from the world leading teaching, research and infrastructure within Trinity College.

SCSS has a strong track record of working with industry, developing intellectual property and creating new ventures and has made a significant contribution to the College's knowledge transfer activity. In the last 5 years Trinity has filed 92 patent applications with 51 patents granted, spun out 17 campus companies and has evaluated almost 300 invention disclosures. 28 new products were launched by Trinity campus companies. SCSS also hosts three National Research Centres, and continues to evolve and lead ground breaking research programmes.

The Business Development team within Trinity Research & Innovation are here to help you identify and access this world class talent. We are keen to develop relationships with industry and to support industry engagement and the commercialisation of Trinity research.



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Industry Engagement & Collaboration

TRINITY IS VERY FLEXIBLE IN HOW WE ENGAGE IN COLLABORATION WITH INDUSTRY

Industry informed research – where industry guides the direction of research through knowledge of the marketplace and end user needs e.g. student projects, advisory boards, internships.

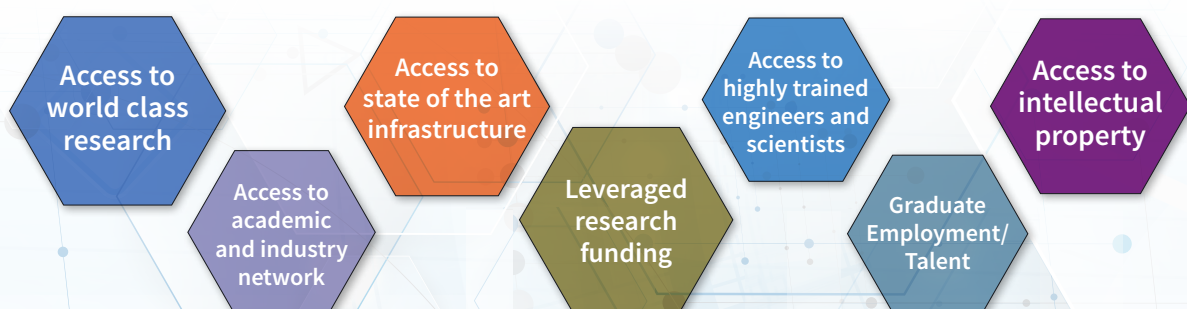
Industry collaborative research – where the work programme is jointly agreed by industry and academic partners. Attractive co-funding schemes are available through a variety of funding agencies.

- Enterprise Ireland's Innovation Partnership Programme – both large and small companies can be eligible for significant exchequer funding support for projects carried out in Trinity which will develop new (or improve) products, service or processes.
- Science Foundation Ireland has a number of schemes that can co-fund research carried out in Trinity within the existing SFI National Centres, or developing new Centres or Spokes. Targeted projects enable short proof of concepts and develop relationships between the industry partner and the academic teams. Co-sponsoring both PhD studentships and post-doctoral fellows is also possible.
- The Irish Research Council has schemes which enable industry to co-sponsor both PhD studentships and post-doctoral fellows.
- Innovation Vouchers worth €5,000 are available to assist a company to explore a business opportunity or problem with Trinity.
- The European Union has a number of programmes which enable industry to undertake collaborative research with Trinity researchers.

Industry directed research – where industry defines the challenge and agrees the research programme with the academic partner. Some national and European funding financial supports are available e.g. consultancy and research services projects.

For more information contact the Business Development Team

BENEFITS TO INDUSTRY



SCSS Research Expertise

ICT Research Excellence in Trinity

Statistics
& Data
Science

Digital
Content
Technology

Internet
of Things
(IoT)

Future
Networks

Future
Cities

Graphics,
Vision,
Augmented
and Virtual
Reality

Security
& Privacy

Artificial
Intelligence

Software
Performance
&
Correctness

Learning
Technologies

Artificial Intelligence

INNOVATIVE RESEARCH IN ALL AREAS OF ARTIFICIAL INTELLIGENCE, INCLUDING:

- Machine Learning
- Deep Neural Nets
- Deep Learning
- Natural Language Processing
- Semantics, Ontologies and Reasoning
- Multi-Agent Systems
- Recommender Systems

SAMPLE APPLICATION AREAS

- Intelligent Transportation Systems (including autonomous vehicles)
- Optimisation of resource usage in large scale dynamic decentralised heterogeneous environments (including smart energy grid and intelligent urban traffic and mobility solutions)
- Visual Computing Applications (including computer vision, image analysis and manipulation)
- Accelerating deep neural networks on embedded systems
- Fraud Detection in social networks
- Personalisation applications
- Dialogue interaction



Engaging Content
Engaging People



Digital Content Technology

PRODUCING GROUND-BREAKING DIGITAL CONTENT INNOVATIONS

PERSONALISATION

- Adaptive composition/authoring
- Information retrieval, just-in-time visualisation
- Multimodal analysis and interaction, HCI
- Intelligent content discovery

KNOWLEDGE-BASED MODELLING & DATA GOVERNANCE

- Semantic web and linked data
- Data management
- Data ethics
- Data governance: integration, quality, value
- Interoperability and federation

CONTENT ANALYTICS

- Stylistics, politeness, events and meaning

SAMPLE APPLICATION AREAS

- Innovative web services for enterprises, Enterprise data management, Technology-enhanced learning in corporate and educational environments, Health & Wellness, Digital Humanities



Engaging Content
Engaging People



LEARNOVATE
Leading Learning Innovation



Graphics, Vision, Augmented and Virtual Reality

Innovative research in computer graphics, computer vision and all aspects of visual computing

CHARACTER ANIMATION

- Motion capture & synthesis
- Appealing characters, avoid “uncanny valley”

REAL-TIME RENDERING & ANIMATION

- Crowd & urban simulation
- Real-time 3D scientific visualisation

COMPUTER VISION

- Gesture recognition, collision avoidance – SureWash, WingWatch
- Computer Graphics/Vision Hardware, Illumination & Display Systems

IMAGE PROCESSING

- Augmented and Virtual Reality (AR/VR)
- Free View-point Video (FVV)
- 360-Video
- Light-Field Technologies
- Visual Effects and Animation
- 3D rendering from 2D images
- Colour transfer/mapping in videos

SAMPLE APPLICATION AREAS

- Interactive entertainment
- Health
- Creative industries



Engaging Content
Engaging People



Future Networks & IoT

Leading the national research, development and innovation activity in future networks, communications and the Internet of Things (IoT)

FUTURE WIRELESS

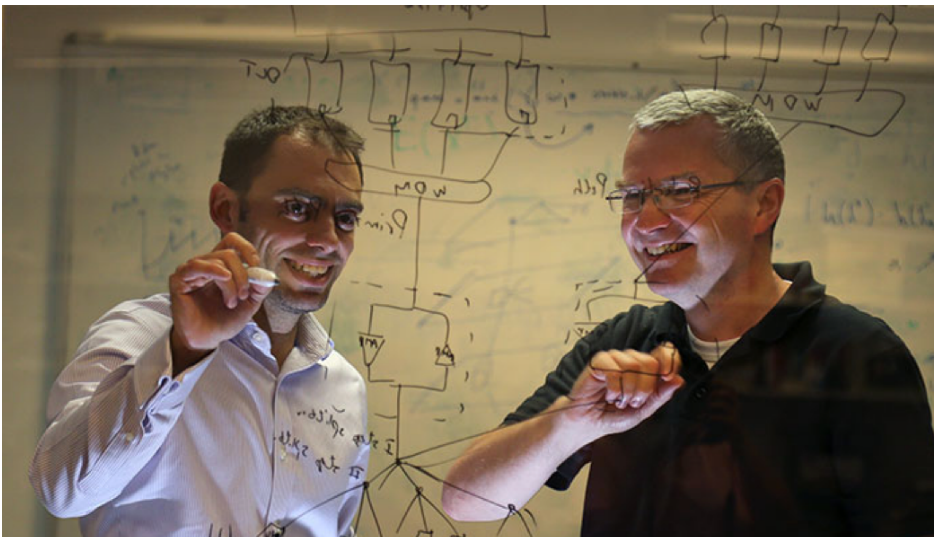
- Small cell/C-Ran/WiFi/Supercell
- Dynamic resource management/sharing
- Multipath, low latency transport
- 5G, Internet of Things

OPTICAL NETWORKS

- Software defined networking
- Optical/wireless convergence

INTERNET OF THINGS

- Nationwide radio infra-structure to connect the 'things'
- Decision Making at scale
- Decision Making with dynamic, conflicting and noisy data sources



Future Cities

Leading the application of sensors, communication and analytical technological solutions to sustainability concerns in urban infrastructure such as energy, water, waste management and transportation systems

URBAN-SCALE SENSING

- Wireless sensor networks
- Participatory sensing

MIDDLEWARE ARCHITECTURES

- Autonomic management
- Model-free learning algorithms

SMART SERVICES

- Intelligent transport (traffic control, driver assistance)
- Community microgrid management



CONNECT
Centre for Future Networks

enable
connecting • communities



Security, Privacy and Data Protection

SECURITY, PRIVACY AND DATA PROTECTION

Research, development and open-source implementation

- Privacy semantics, including automated GDPR compliance and data policy management
- Electronic identity systems
- Electronic payment systems
- Blockchain and crypto-currency applications
- Alternatives to passwords (e.g. RFC7486) and new approaches to naming (e.g. RFC6920)
- Privacy friendly features for phones
- Privacy-enhanced recommender systems and search, traffic analysis resistant VPNs and HTTPS
- PKI, Federated access control

MEASUREMENT

Measuring real security and privacy characteristics of deployed systems on the public internet

- Web-site “scoring”
- Localised Internet measurement
- Mobile handset monitoring

STANDARDISATION

Bridging the gap between research and standards

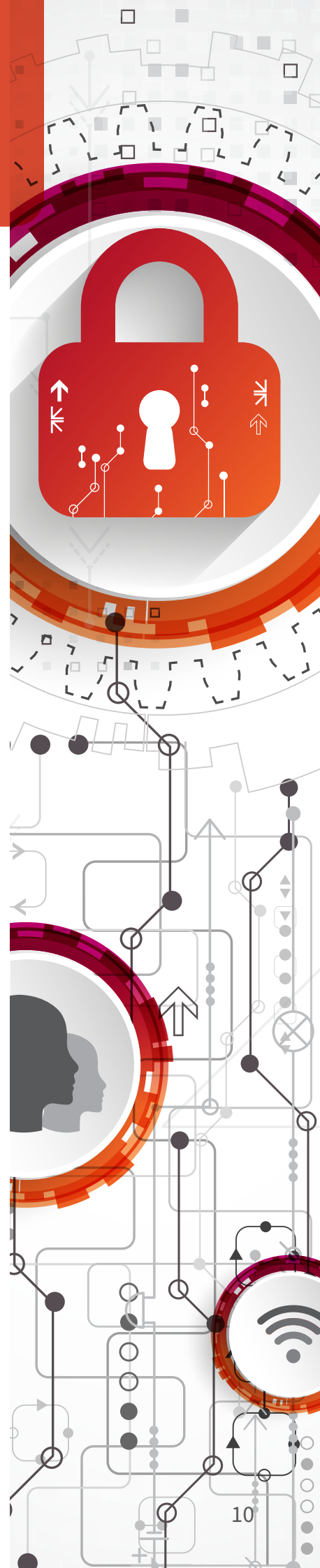
- Involvement and Leadership in Internet Engineering Task Force (IETF), World Wide Web Consortium (W3C) working groups, and LoRa Alliance security working group.



Engaging Content
Engaging People

CONNECT
Centre for Future Networks

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Statistics & Data Science

Developing and applying statistical inference, decision theory & optimisation, machine learning and visualisation techniques that will process data and draw new insights and knowledge from the data.

BAYESIAN INFERENCE

- Time-series analysis, streaming data
- Robust statistics, inverse regression
- Scalable algorithms (Big Bayes)

DECISION THEORY & OPTIMISATION

- Adaptive utility, sequential decision-making
- Lightweight and private optimisation

MACHINE LEARNING

- Linear & Log

DATA VISUALISATION

- Visual Information – perception and understanding
- Graph, Spatial and Interactive data visualisation

SAMPLE APPLICATION AREAS

- Ecology, astronomy
- Vision/video
- Social networks
- Health
- Fintech



Engaging Content
Engaging People

Software Performance & Correctness

Designing algorithms, developing graphics cards, static and dynamic analysis

SOFTWARE PERFORMANCE

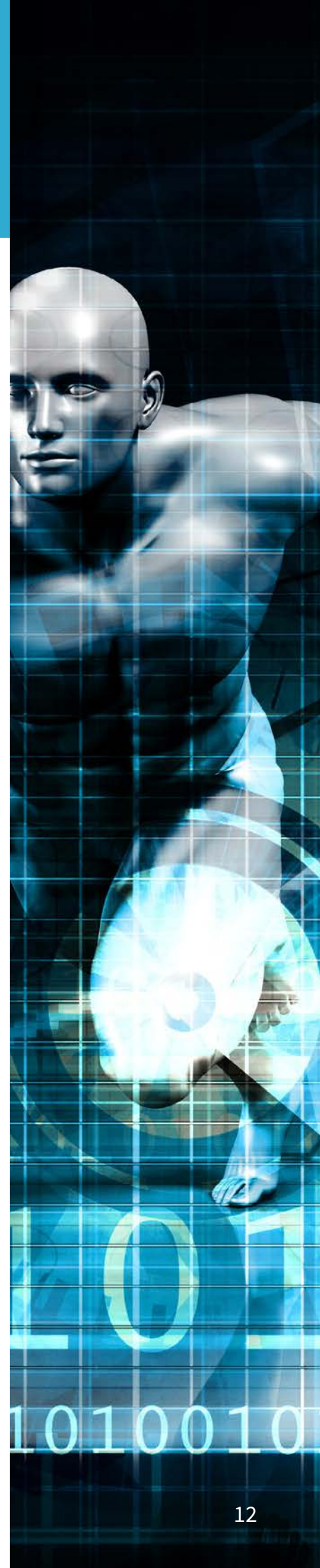
- Low-energy computing
- Compilers and parallelization for multicore
- Algorithm design for parallelism & locality

FOUNDATIONS OF COMPUTATION

- Programming abstractions for parallel computing
- Proof techniques for software correctness
- Verification & static analysis for critical systems

SAMPLE APPLICATIONS AREAS

- Smart embedded, mobile and space systems
- Safety-critical medical systems



World renowned centre for research in **digital content technology**, a hub of expertise that supports collaborative innovation to unlock the potential of all digital content, empower and enhance engagement online between people, and promote creativity, competitiveness and entrepreneurship for Ireland.



Engaging Content
Engaging People



ADAPT Partners are developing ground-breaking innovations to turn the enormous volume of content into digital revenues by enabling unprecedented levels of global engagement between organisations and customers via world-leading research. Leveraging €50 million in new investment, ADAPT research focuses on:

- Analysing media, content and customer interactions to enhance communication, customer engagement and satisfaction
- Enhancing global reach via innovative machine translation of corporate and user-generated content
- Transforming and delivering personalised content to empower customers and companies
- Enabling innovative customer engagement across multimodal media (speech, video, image, text) to enhance the user experience
- Extracting actionable knowledge from all forms of digital content and user interactions

Current networks are proving a roadblock to solving some of the world's most pressing problems. We all want faster and richer data but networks are currently overwhelmed by this traffic. CONNECT's mission is to research and develop innovative solutions for the communications challenges facing society today.



CONNECT researches future networks, Internet of Things, 5G and beyond from the following network perspectives:

- Converged Networks
- Dense Networks
- Low Energy Networks
- Moving Networks
- Nano Networks
- Shared Networks

FACILITIES

CONNECT researchers have vast expertise in test and experimentation in these areas. At Trinity, CONNECT provides access to following testbed facilities:

- Pervasive Nation – Ireland's Internet of Things testbed using a Low Power Wide Area Network (LPWAN). See www.pervasivenation.ie
- Wireless testbeds for cellular, Cloud-RAN and SDR
- Optical networking testbeds

INDUSTRY AND COMMERCIALISATION

CONNECT works with a wide range of industry partners on targeted projects in the areas of Internet of Things, future cellular (5G and beyond), next-generation broadband, software-defined networks and cloud-based services. CONNECT's expert researchers are dedicated to delivering outstanding results at the pace and standard demanded by industry.



Smart environments.

Connected communities.



Sustainability of our cities requires finding new ways to enable behavioural change, the solutions to which are inherently multi-disciplinary. This SFI Spoke Enable leverages expertise from the CONNECT, Insight and Lero Research Centres, and is multi-disciplinary collaboration between 20 PIs from 7 HEIs, 28 companies and Dublin and Cork City Councils.

Enable will develop new technology to improve the way we manage our cities to benefit people, communities and the environment. Sensors and mobile devices will be linked in large, well-managed networks. The focus is on making better decisions from the data gathered, providing up-to-date information for people in towns and cities, while keeping personal data private and the networks secure.

We aim to **enable smarter services in the city**, including transport, water and energy management, **reduce pollution, improve our work places**, and allow **everybody to take part in the decisions**.



enable-research.ie



Learnovate is one of Europe's leading research and innovation centres in learning technologies.



An industry-led technology centre funded by Enterprise Ireland, Learnovate connects world-leading research in higher education with entrepreneurs at the leading edge of the global learning technologies sector. Learnovate research fuses expertise in technology, the learning sciences, product design, user experience and strategic innovation to drive commercial success for our industry partners.

The aim of Learnovate is to maximise the growth potential of individual companies working in the EdTech and e-learning sector and enhance Ireland's competitiveness as a global leader for learning technology innovation. Learnovate's industry-led collaborative research programme develops and exploits breakthrough learning technologies for the collective benefit of Ireland's learning technologies sector. Member companies actively set the research agenda and receive preferential licensing opportunities for Intellectual Property arising from core research.

Learnovate offers strategic research and innovation services to individual companies that develop learning technologies; and companies that acquire and use learning technologies. The centre's expertise and experience encompasses a wide range of learning contexts including corporate learning, higher-ed learning, school learning, and non-formal learning. Learnovate

helps identify, secure and maximise the value of funding for member companies through innovation vouchers and innovation partnerships with Enterprise Ireland.

Organisations who have collaborated with Learnovate include Intel, Microsoft, BNY Mellon, WBT Systems, Sureskills, CJ Fallon, Cobblestone Learning, Ellucian and Houghton Mifflin Harcourt. Areas of research undertaken in collaboration with member companies include:

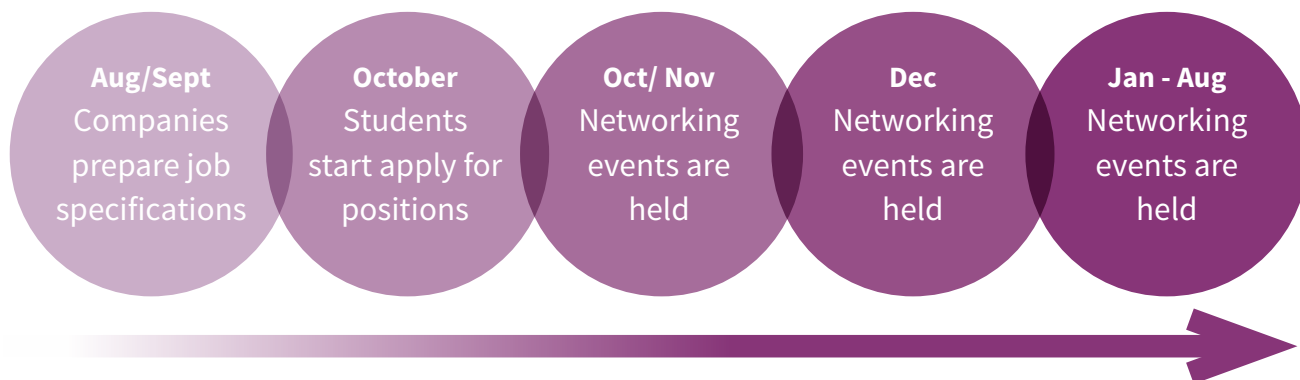
- Digital Content
- Games and Gamification
- Interoperability
- Learning Analytics
- Personalisation
- Social Networks



Student Internships

**COMPUTER SCIENCE (BACS/MCS) / COMPUTER ENGINEERING (BAI/MAI)
ELECTRONIC AND COMPUTER ENGINEERING (BAI/MAI)**

INTERNSHIP TIMELINE



FEATURES AND BENEFITS

- Access to skilled students who have completed 3.5 years of computer studies.
- Internships of up to seven months paid.
- A pool of potential future employees.
- The chance to connect with active researchers in Computer Science.
- An opportunity to cultivate in-house managerial and supervisory skills by mentoring interns.

Contact: www.scss.tcd.ie/internships

Student Internship Industry Partners 2018



Courses at SCSS

With demand for training ICT professionals at an all-time high, Trinity is seeing an increase in student numbers for both undergraduate and postgraduate courses. Graduates from SCSS are highly sought after by industry and find employment around the world.

POSTGRADUATE COURSES

- MSc in Computer Science (Data Science / Future Networked Systems / Augmented and Virtual Reality / Intelligent Systems AI)
- MSc in Interactive Digital Media
- Postgraduate Certificate in Statistics (part time)
- PhD Programme

UNDERGRADUATE COURSES

- Computer Science (Bachelor and integrated Master's programme)
- Computer Science and Business
- Computer Science and Language
- Computer Engineering
- Management Science and Information Systems Studies

EVENTS TO MEET OUR STUDENTS

Masters Dissertation Event

The School hosts a Masters Dissertation event annually to provide an opportunity for business, industry, the public sector and academia to link with graduates who are showcasing their research on the MSc programmes.

Computing Careers Fair

The School collaborates with leading industry players and hosts an annual special recruitment fair where employers meet students from our courses to discuss employment opportunities. This is open to all students in Trinity College to attend.





Trinity College Dublin

Coláiste na Tríonóide, Baile Átha Cliath

The University of Dublin



Trinity Research & Innovation
O'Reilly Institute
Trinity College Dublin, the University of Dublin
www.tcd.ie/innovation