Faculty of Science and Health Dublin City University

Naughton projects for visiting Notre Dame students 2017

Area and Depth Profiling of Active Pharmaceutical Ingredients (APIs) in Tablets using Laser Induced Breakdown Spectroscopy (LIBS)

Dr. Paddy Hayden (Patrick.hayden@dcu.ie), Prof. J. T. Costello (john.costello@dcu.ie)
School of Physics & NCPST, DCU, Dublin 9, Ireland

Project Aims/Objectives

Laser Induced Breakdown Spectroscopy (LIBS) is a standard approach for classifying materials be they solid, liquid or gas [1]. LIBS involves using a laser to create an ionized vapour on the surface of a large sample to create a plasma. The spectrum of light emitted from the plasma is characteristic of the elemental composition of the sample, effectively a chemical fingerprint. Hence LIBS can be used to classify (and potentially quantify) the presence of an element on a host. For example we have used LIBS to determine the presence of carbon in steel [2]. The distribution of the API following tabletization in of key interest to the industry and researchers as it affects the takeup of the API by the human system and hence the efficiacy of the drug. Micro Raman Spectroscopy (MRS) can be used to profile the API but it is hugely time consuming and expensive. LIBS is a single laser shot technique and combined with a tight laser focus offers the prospect of being competitive with MRS. If time permits, we will combine employ double pulse LIBS [3] to further optimise the LOD. For the expected complex/rich spectra we will employ statistical techniques, especially Principal Component Analysis [4], for which we have a suite of codes developed by one of the group.

Research Group / Techniques.

The Laser Plasma and AMO at the School of Physics in DCU is well established in intense laser matter interactions. We have a suite of well-equipped laboratories, for a list of equipment – cf. http://www.physics.dcu.ie/~jtc/expfacil.html. The group currently comprises 4 faculty members, 1 SFI Fellow, 3 postdoctoral fellows and 10 research students. Our high power lasers produce pulses from the femtosecond to nanosecond range and our spectrometers cover the NIR to soft X-ray range. As a member group of the National Centre for Plasma Science and Technology at DCU we also have access to many materials diagnostics like XRD, AFM, SEM, etc. We also have a number of codes for atomic spectra calculations to aid LIBS.

Potential Candidates

This project would suit a student who has interest in analytical sciences, lasers, optics and spectroscopy. The project involves skills such as optical alignment, vacuum technology and data processing in MATLAB. The candidate should be comfortable working in a high power (Class IV) laser environment (appropriate training will be given and the student will be accompanied by an experienced research student and/or postdoc at all times).

References

[1] R. Noll, Laser-induced Breakdown Spectroscopy, Springer (2012)

[2] X Jiang, P Hayden, J T Costello and E T Kennedy, Dual-Pulse Laser Induced Breakdown Spectroscopy with Ambient Gas in the Vacuum Ultraviolet: Optimization of Parameters for Detection of Carbon and Sulphur in Steel *Spectrochimica Acta Part B: Atomic Spectroscopy* **901** 106-113 (2014)

[3] M.A. Ismail, G. Cristoforetti, S. Legnaioli, L. Pardini, V. Palleschi, A. Salvetti, E. Tognoni, M.A. Harith, Comparison of detection limits, for two metallic matrices, of laser induced breakdown spectroscopy in the single and double-pulse configurations, *Anal. Bioanal. Chem.* **385** 316–325 (2006)

[4] S. M. Clegg, E. Sklute, M. D. Dyar, J. E. Barefield and R. C. Wiens, Multivariate analysis of remote laser-induced breakdown spectroscopy spectra using partial least squares, principal component analysis, and related techniques *Spectrochimica Acta Part B* **64** 79–88 (2009)

Design and Manufacturing of Microfluidic Lab-on-a-Chip Systems

Jens Ducree, Director Fraunhofer Project Centre, Head of Microfluidics Research Group, School of Physical Sciences, Dublin City University, Glasnevin, Dublin 9, Ireland

Email:jens.ducree@dcu.ie

Background

The DCU Microfluidics research group is directed towards novel microfluidic platforms and associated actuation, detection, fabrication and instrumentation technologies for the integration, automation, miniaturization and parallelization of sample preparation and detection of bioanalytical assays (e.g. immunoassays, nucleic acid testing, general chemistry and cell counting). Typical applications are sample-to-answer systems for biomedical point-of-care and global diagnostics, liquid handling automation for the life sciences (e.g. concentration / purification and amplification of DNA / RNA from a range of biosamples), monitoring the environment, infrastructure and agrifood.

Project description

Similar to smartphones that have brought a wide range of physical sensing capabilities and their embedding into ITC and big data networks to our everyday lives, microfluidic Lab-on-a-Chip gadgets are slated to bring the significant achievements of 21st century life sciences to our finger tips for the benefit of people and societies. Fields of application range from personalised medicine and agrifood to monitoring of nature, industry and public infrastructures. The group at Dublin City University develops next-generation Lab-on-a-Chip systems, strategically expanding present capabilities towards large-scale integration (LSI), programmability and mass customisation. The Naughton internship will address important microfluidic design and microfabrication aspects. The candidate should have a keen interest in hands-on experimental work and to manufacture and test advanced Lab-on-a-Chip systems currently developed in the group.

Using the Rossiter-McLauglin effect to map giant exo-ring systems

Dr. Ernst de Mooij (Ernst.DeMooij@dcu.ie)
School of Physical Sciences, Dublin City University

Background

Mamajek et al. (2012) analysed light curve data from the SuperWASP data for the star 1SWASP J140747.93–394542.6 (J1407 for short). This star is relatively young, only 16MYr, and active, showing photometric modulations due to star spots with an amplitude of 5% on a period of 3.21days. More interestingly, they also noticed a very strong dimming event in 2007, which lasted ~60 days (see Fig. 1). For over 5 days in the middle of this event, the star's flux dropped well below 10% from its undimmed value. Even more interesting is the presence of a large amount of sub-structure in the light curve throughout the event. Van Werkhoven et al. (2014) identified at least 24 different structures over the course of the first half of the event and 16 during the latter half. These structures are interpreted as the presence of a large transiting disk with at least 24 individual rings. Such a disk would be expected to orbit an unseen planet, and the presence of the rings would then indicate the presence of exo-moons that interact with the ring particles, just as is seen for the rings and moons of Saturn.

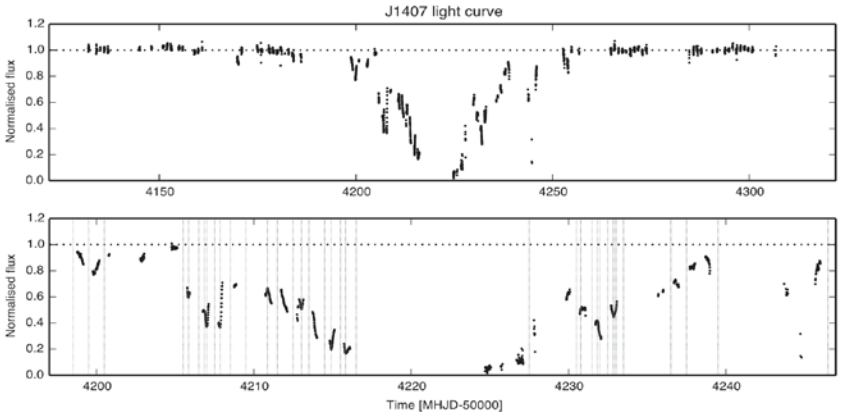

***Figure** 1: Light curve of J1407b taken from Van Werkhoven et al. (2014). Top panel: All data for 2007, bottom panel: zoom on the eclipse event.*

Since the 2007 transit event, no further events have been observed, but if the transiting object is bound, it should transit again in the future, providing us with an opportunity of studying moon systems around young exoplanets.

In De Mooij, Watson and Kenworthy (in prep.) we propose a novel method to map the structure in relatively small exo-ring system (similar to Saturn's rings) by directly fitting the distortions of the stellar line profile due to transiting objects (the Rossiter-McLaughlin effect). This technique works best for rapidly rotating stars, where the material occults a large range of projected velocities on the stellar surface. The advantage over photometric time series is that this technique does not require continuous monitoring to determine the shape of the transiting object, but can, if the SNR is high enough, rely on short 'snapshot' observations.

This project

The aim of this project is to expand on the method from De Mooij, Watson and Kenworthy (in prep.) in order to demonstrate that this technique can also be used to map giant transiting ring systems. This is particularly of interest in relation to future transits of the J1407b exo-ring system. The project will focus on adapting the original code used in De Mooij, Watson & Kenworthy (in prep.) to allow the modelling and fitting of giant rings that are much larger than Saturn's rings. This new code will then be used to simulate realisitc high-resolution spectra of stars undergoing events like that of J1407b. By fitting these simulations, we will be able to investigate our abilities of recovering the shape of the ring parameters, and potential degeneracies, as well as develop optimal strategies for the observations (e.g. sampling frequency vs. integration time) and combining spectroscopic and photometric data.

References

Mamajek et al. 2012, AJ, 143, 72;
Van Werkhoven et al. 2014, MNRAS 441, 2845;

Faculty of Engineering and Computing Dublin City University

Projects for Naughton-funded visiting Notre Dame students 2017

Project 1

Host Institution:	Dublin City University (DCU)
Location:	Dublin 9, Ireland
Website:	www.dcu.ie
Faculty:	Engineering & Computing
School:	Mechanical and Manufacturing Engineering
Project Lead:	Prof. Nicholas Dunne and Dr. Tanya Levingstone
Email contact:	nicholas.dunne@dcu.ie; tanya.levingstone@dcu.ie
School Website:	www.dcu.ie/mechanical_engineering

Project Title:

Development of Biomaterials for Bone Fracture Repair

Brief Project Description:

Bone fractures present a significant burden to the public health system. Fractures cause pain, reduce function, induce disability and result in a lower quality of life. The annual combined medical and social care costs associated with bone fractures is estimated to be £3B in the UK and Ireland, and with an ageing population this is set to rise further. Current treatments options involve harvesting bone from the pelvis and grafting this into the defective bone. This 'gold standard' can result in numerous complications including nerve/arterial injury, infection, chronic pain and donor site morbidity. Successful commercially available bone graft substitutes are limited as none of the current bone grafts exhibit all the four key biological characteristics that are essential for successful bone regeneration. Therefore, an effective 'off-the-shelf' bone graft substitute that replicates most or all of the biomechanical and biological advantages of the 'gold standard' would have a distinct clinical advantage.

Researchers within the School of Mechanical and Manufacturing Engineering at DCU are currently creating injectable hydrogel systems that are liquid at room temperature and upon injection into the human body form a gel. These gel are loaded with ceramic nanoparticles that are purposefully designed to mimic the biological processes required for effective bone regeneration. The over-arching principal is that once implanted, these hydrogels systematically degrade releasing the ceramic nanoparticles to target the local cellular environment and regenerate bone. The focus of this internship is to assist in the development of the technical data dossier through characterisation of the mechanical, rheological and degradation properties of differing hydrogel systems in order to determine the optimal biomaterial composition for further development.

Project Dates:

From the end of May to August 2017 (specific dates can be agreed between the PI and the student directly)

Application Criteria:

This project would suit students from a biomedical / materials / chemical engineering background

ADAPT Centre, Dublin City University
REU Program 2017
Undergraduate Internship Project Description

Project 2

Project title:	Minority Language Technology	
Suitable for students who are studying in the following areas:	Computer science, language technology, language studies (with CALL or other technical application interests).	
Skills needed:	– Language and linguistic understanding (second language is a plus) – Confident technical aptitude (Python or Perl skills preferred) – An interest in minority/less resourced languages (specifically Irish) is a plus.	
Project description:	The Irish Language Technology research group at the ADAPT Centre has a specific interest in developing resources for Irish, which in turn benefits the wider minority/less resourced language technology community. Previous work includes treebank development, statistical parsing, pos-tagging of Irish tweets and English-Irish MT. 2017 will see a continuation of work in all of these areas of research, while broadening out to apply syntactic resources to CALL systems and investigate the processing of multiword expressions. As with our previous internship opportunities, the intern may be exposed to a number of aspects of our research before we jointly ascertain which topic they will (i) benefit from in terms of career and research goals and (ii) bring the most value to the team's objectives. While the priority language of our research group is Irish, we welcome applicants without Irish who can demonstrate how NLP techniques can be easily transferred to a minority/less resourced language.	
The role of the student in this project:	– Reading scientific publications on Irish NLP and that of other minority/less resourced languages – Applying linguistic knowledge to the analysis of text (standard or user-generated content) – Applying linguistic knowledge to the development of scripts to convert or analyse data – Becoming familiar with language-independent NLP tools such as web-crawlers, Moses, MaltParser, POS tagger frameworks. – Exploring ways in which to overcome lack of data in the automatic processing of minority/less resourced language data/content.	
Short description of the group:	The ADAPT Centre for Digital Content Technology (www.adaptcentre.ie) is a dynamic research centre that combines the world-class expertise of researchers at four universities (Dublin City University, Trinity College Dublin, University College Dublin and Dublin Institute of Technology) with that of its industry partners to produce ground-breaking digital content innovations. ADAPT brings together more than 150 researchers , who collectively have won more than €150m in funding and have a strong track record of bridging research and innovations to more than 140 companies.	
Suggested project dates:	The intern is welcome to join the Irish language technology team for 10 weeks at any stage between the beginning of June and mid-August 2017.	
For further details on this project please contact:	**Name:** **E-Mail:** **Website:**	**Dr. Teresa Lynn** **teresa.lynn@adaptcentre.ie** **http://www.computing.dcu.ie/~tlynn/**

ADAPT Centre, Dublin City University
REU Program 2017
Undergraduate Internship Project Description

Project 3

Project title:	'Tinder' For Researchers: Fostering internal communication and collaboration in a large research workplace	
Suitable for students who are studying in the following areas:	Computer science or Data Science or Statistics	
Skills needed:	- Good programming skills: Java or Python - Good knowledge in Machine Learning and/or Natural Language Processing is a plus	
Project description:	This project aims to adapt a matching algorithm based upon data collected from researchers profiles and publications in order to effectively identify potential partners who are compatible for a long-term collaboration.	
The role of the student in this project:	- Collect and annotate a small dataset - Develop and test the matching algorithm using the collected data	
Short description of the group:	The ADAPT Centre for Digital Content Technology (www.adaptcentre.ie) is a dynamic research centre that combines the world-class expertise of researchers at four universities (Dublin City University, Trinity College Dublin, University College Dublin and Dublin Institute of Technology) with that of its industry partners to produce ground-breaking digital content innovations. ADAPT brings together more than 150 researchers , who collectively have won more than €150m in funding and have a strong track record of bridging research and innovations to more than 140 companies.	
Suggested project dates:	10-week internship between May-August 2017. Specific dates to be decided based on the availability of the applicants.	
For further details on this project please contact:	**Name:** **E-Mail:** **Website:**	**Dr. Lamia Tounsi** **Lamia.tounsi@adaptcentre.ie** **http://adaptcentre.ie/**

ADAPT Centre, Dublin City University
REU Program 2017
Undergraduate Internship Project Description

Project 4

Project title:	Machine Learning and image recognition	
Suitable for students who are studying in the following areas:	Computer Science, Image processing, Information Retrieval	
Skills needed:	Some ML experience, HPC computing, Image processing, git	
Project description:	Use ML to query an extensive set of data to retrieve relevant images based on image content and meta information	
The role of the student in this project:	We expect a student who is proactive and can work well in a team. The student will work on ML/IR projects together with Research Engineers and Post-Docs.	
Short description of the group:	The ADAPT Centre for Digital Content Technology (www.adaptcentre.ie) is a dynamic research centre that combines the world-class expertise of researchers at four universities (Dublin City University, Trinity College Dublin, University College Dublin and Dublin Institute of Technology) with that of its industry partners to produce ground-breaking digital content innovations. ADAPT brings together more than 150 researchers , who collectively have won more than €150m in funding and have a strong track record of bridging research and innovations to more than 140 companies.	
Other information (incl. suggested project dates):	The student will work in ADAPT's Design & Innovation lab on exciting projects in collaboration with interesting Industry Partners. We're flexible in regards with the start date of the 10-week internship.	
For further details on this project please contact:	**Name:** **E-Mail:** **Website:**	Joris Vreeke joris.vreeke@adaptcentre.ie www.adaptcentre.ie

Project 5: ADAPT Centre, Dublin City University
REU Program 2017
Undergraduate Internship Project Description 5

Project title:	Building Earth Sensory Systems from Online Information	
Suitable for students studying in the areas:	Computer Science, Natural Language Processing	
Keywords:	Earth Sensory Systems, Online Discussion Forums, Mobile Devices Sensory Signals, Natural Language Processing, Discrete Signal Processing, Perception Modelling	
Project description:	Sensory systems on a massive scale to monitor regional, continental, and/or global events are crucial infrastructures for us to better assess our environments and make necessary responses to the events that have great impacts on humans. Examples of traditional sensory systems include Tsunami Warning Systems, Plate Boundary Observatory in Taiwan and Earthquake Early Warning in Japan. The building of these systems is very expensive and requires state and international investments. In this programme the fellow will learn plausible approaches using online information to build sensory systems for Earth. The idea came from the facts that whenever there is a contingency, there are always corresponding posts in the internet, and usually in seconds. We have observed this phenomenon in many events such as earthquake and typhoon strikes, and 2014 Kaohsiung gas explosions in Taiwan. Currently there are efforts taking advantage of motion sensors, microphones and GPS locations, etc., to detect events from mobile devices, challenges arise to integrate multimodal signals for the understanding of each event. The fellow will learn to use available online information, including sensor signals from mobile devices and especially posts from online forums, etc., to build Earth Sensory Systems. Posts by humans will be the first focus in this programme because this information has been interpreted by humans and therefore are usually more informative than sensor signals can tell us. To take advantage of this information, relevant natural language processing techniques need to be surveyed and developed. In addition to the online information as sensors, the second focus of this programme will be on the perception modelling, which is used to interpret if there is any event and if there is, what type of the event is. The third focus of this programme is on the privacy issue. To build such, users often have to provide precise information which reveals too much privacy to the systems. The fellow of this programme will survey and develop techniques which allow users to provide imprecise information to address the privacy issue. Perception modelling will be designed and relied on this imprecise information. The results of this programme will be functional Earth Sensory Systems which can be used to detect events of interests from online information.	
Short description of the group:	The ADAPT Centre for Digital Content Technology (www.adaptcentre.ie) is a dynamic research centre that combines the world-class expertise of researchers at four universities (Dublin City University, Trinity College Dublin, University College Dublin and Dublin Institute of Technology) with that of its industry partners to produce ground-breaking digital content innovations. ADAPT brings together more than 150 researchers , who collectively have won more than €150m in funding and have a strong track record of bridging research and innovations to more than 140 companies.	
Project Dates:	10-week internship between May-August 2017. Specific dates to be decided based on the availability of the applicants.	
For further details on this project please contact:	**Name:** **E-Mail:** **Website:**	Chao-Hong Liu chaohong.liu@adaptcentre.ie www.adaptcentre.ie

Project 6: Comparative Performance Study of Proactive Routing Protocols for Unmanned Aerial Vehicles (UAV)-based Ad-Hoc Networks

Background/Research Motivation

In recent years, Unmanned Aerial Vehicles (UAV) are seen as competitive candidates for military, public and civil applications to carry out tasks such as data delivery, sensing, surveillance and even attack. Among these applications, of very much importance are communication-based applications and in this context the ad-hoc networks are considered most suitable for the multi-UAV systems to support the associated data exchange.

In the past decade, there have been mature routing protocols proposed for traditional Mobile Ad-hoc Networks (MANET) and Vehicular Ad-hoc Networks (VANET). However, UAV ad-hoc networks are significantly different from MANETs/VANETs as the potential high moving speeds cause fluid network topologies and intermittent links. Existing ad-hoc routing protocols would suffer from excessive overhead and frequent route break-downs if directly applied to UAV networks. However, the investigation of routing protocol efficiency in UAV ad-hoc networks is still in its early stages.

Project tasks

Perform modeling and simulations to study the performance of proactive routing protocols (e.g. OLSR, DSDV, BABEL) in UAV ad-hoc networks with different degrees of mobility, ranging from slow dynamics to fast dynamics.

Dr. Gabriel-Miro Muntean, DCU School of Electronic Engineering
email: gabriel.muntean@dcu.ie
web: http://www.eeng.dcu.ie/~munteang/

Project 7: Comparative Performance Study of Reactive Routing Protocols for Unmanned Aerial Vehicles (UAV)-based Ad-Hoc Networks

Background/Research Motivation

In recent years, Unmanned Aerial Vehicles (UAV) are seen as competitive candidates for military, public and civil applications to carry out tasks such as data delivery, sensing, surveillance and even attack. Among these applications, of very much importance are communication-based applications and in this context the ad-hoc networks are considered most suitable for the multi-UAV systems to support the associated data exchange.

In the past decade, there have been mature routing protocols proposed for traditional Mobile Ad-hoc Networks (MANET) and Vehicular Ad-hoc Networks (VANET). However, UAV ad-hoc networks are significantly different from MANETs/VANETs as the potential high moving speeds cause fluid network topologies and intermittent links. Existing ad-hoc routing protocols would suffer from excessive overhead and frequent route break-downs if directly applied to UAV networks. However, the investigation of routing protocol efficiency in UAV ad-hoc networks is still in its early stages.

Project tasks

Perform modeling and simulations to study the performance of reactive routing protocols (e.g. DSR, AODV) in UAV ad-hoc networks with different degrees of mobility, ranging from slow dynamics to fast dynamics.

Dr. Gabriel-Miro Muntean, DCU School of Electronic Engineering
email: gabriel.muntean@dcu.ie
web: http://www.eeng.dcu.ie/~munteang/

Project 8: Exploring Digital Mirrors

Taking a different look at ourselves by bringing together art and science

This internship project is the continuation of an ongoing art-science collaboration within the Insight Centre for Data Analytics[1] at Dublin City University that is designed to inspire and excite the general public via fun interactive technology demonstrations.

A traditional mirror shows us a reflection of ourselves, but a digital mirror, corresponding to a camera feed manipulated by real-time image processing software and visualized on a display, has the ability to change that reflection in interesting and fun ways. Recognising this, the Insight Centre has an ongoing collaboration with two Irish digital artists Connolly-Cleary[2], who create engaging and experimental work centred on observer participation and POV devices.

To date, this collaboration has allowed us to take fundamental concepts in visual perception, and then implement demonstrator versions of the concepts in operation but modified, skewed or adapted for public display. For example, in the "Joining the Dots" exhibit we took Gunnar Johansson's seminal work on the perception of human bodies in motion and recreated an interactive "dot man" mirror using a MS Kinect whereby participants could visualize their body's movement as part of a whirling starscape[3]. As another example, motivated by the "Mystery of the Slanting Car", a photograph by Jacque Latrigue from 1912 where time and space seem to interact in strange ways[4], we implemented the "Real-time Rolling Shutter", a digital mirror that allows observers twist their bodies into strange and unexpected shapes[5].

Our digital mirrors have been exhibited all over Europe including in a dedicated 6 month exhibition in Farmleigh House in Dublin (15,000+ visitors), Place de l'Hôtel de ville de Paris for Europe Week and even in the EU parliament. The demonstrators are regularly used as part of DCU's Open Day and when visiting schools as part of Insight's Education and Outreach mission. In all cases, the goal was to have the audience, particularly children, participate and have fun whilst learning about participative art, human perception and visual sensing.

Internship Project

The current implementations of our digital mirrors are now 3-4 years old and need to be re-implemented using state of the art technologies. One objective of this project is to update/extend/recreate the existing implementations to make them more user-friendly. A second objective is to engage with the artists to discus new concepts that could be implemented. For example, we believe that our recently published computer vision research on highly accurate crowd counting using deep convolutional neural networks[6] could be the basis for an interactive demonstration in public spaces based on crowd movement. However, the project is open-ended providing an opportunity for the successful candidate to bring his/her own ideas to the table.

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[1] See: http://insight-centre.org/
[2] See: http://www.connolly-cleary.com
[3] See: http://www.connolly-cleary.com/Home/Dots.html
[4] See: https://www.youtube.com/watch?v=Q0Vj-7p8FSM
[5] See: https://www.youtube.com/watch?v=Fg9Ph53ka2I
[6] See: Marsden et al, "Fully Convolutional Crowd Counting On Highly Congested Scenes", VISAPP 2017

Prerequisites

This project would suit a creative electronic engineering or computer science student with an interest in human perception, computer vision and real-time processing. Strong programming skills are required e.g. Java, Python, C++, Objective-C, C#, C, etc. Prior experience of image processing is strongly recommended.

Contact:

For more information contact Prof. Noel O'Connor, Insight Centre for Data Analytics, Dublin City University, Email: Noel.OConnor@dcu.ie

Project 9

The Insight Centre for Data Analytics is one of Europe's largest data analytics research organisations, with over 350 researchers, more than 40 industry partners and over €88 million of funding. Insight undergraduate internships, which have been running for 8 years continuously, offer exceptional undergraduate students the opportunity to participate and contribute to exciting research projects at Insight, which allows the student to use leading research facilities, to work with world class researchers, and to inspire these students to take the first step on a path to a research career.

Through the Insight Undergraduate Internship, interns are:

- Given the opportunity to undertake research in a co-operative environment;
- Introduced to research via relevant and stimulating real-world applications which re used in ongoing research projects;
- Exposed to new research problems, interdisciplinary research exploration as well as the use of high-tech equipment;
- Given groundwork in basic research skills, which assist the interns in transforming the internship experience into a long term plan for research career options;
- Given training in communications skills and present an elevator pitch of their project at a centre-wide Research Showcase event in Aug 2017 at the Leopardstown Racecourse alongside other patricipants in the programme.

Project description

In 2016 the National Institute of Standards and Technology in Gaithersburg, Md., ran a global benchmark activity to test the quality of systems which automatically generate a text caption or description, for short videos. This was part of a long-running annual benchmark event called TRECVid, and was coordinated by Alan Smeaton from DCU. Systems automatically generated a text caption for each of 2,000 short video clips, and submitted them to NIST for assessment. The ground truth against which the submitted captions were assessed, were 2 manually generated captions for each of the 2,000 short videos and we used a range of metrics drawn from the machine translation area, including BLEU, METEOR and CIDEr. Unfortunately, because there is so much variety in the ways in which we can describe something visual, the measures used in TRECVid in 2016 were inadequate as they penalised what were good captions generated by the automatic systems but which described the videos from a different vantage. For example, "Young girl and dog playing on a carpet", "Dog mimics baby crawling on floor", "Friendship between child and pet", are all correct descriptions of one of the video clips but they describe it from different (semantic) viewpoints, as well as using different words.

This internship is to evaluate the efficacy of a new idea for evaluating the quality of video captions by taking a crowdsourced approach. The basis is to take all captions generated for a video, manually or automatically, and to cluster them based on similarity to each other. From this should emerge outliers, or ones which are different to the "crowd" of captions. As a test dataset will use a subset of the of 200,000 short videos recently made available by Microsoft Research, each of which has up to 20 manually assigned captions. The ideal candidate will have good programming skills, and preferably have an interest in multimedia and language processing, or both. The project will be supervised by Alan Smeaton with input and skype meetings with Dr. George Awad of NIST.

Prof. Alan F. Smeaton MRIA
Director, Insight Centre for Data Analytics, Dublin City University, Dublin 9, IRELAND.
Email: alan.smeaton@DCU.ie Tel: +353 - 1 - 7005262
http://www.computing.dcu.ie/~asmeaton