INNOVATIVE INDUSTRY ENGAGEMENT IN DATA SCIENCE: A UTS EXPERIENCE

Professor Michael Blumenstein
Associate Dean (Research Strategy & Management)
Head, School of Software

SAS Data Science and Advanced Analytics Forum
April 26 – 27 | Cary, NC

Innovation in practice
eng.uts.edu.au • it.uts.edu.au
UNIVERSITY OF TECHNOLOGY SYDNEY

Our vision is to be a world-leading university of technology.

Our purpose is to advance knowledge and learning to progress the professions, industry and communities of the world.
UNIVERSITY OF TECHNOLOGY SYDNEY (UTS)

Established 1988

42,670 students
10,860 Postgraduate students
1,720 research students
12,380 international students
3,350 full time staff

Over 380 partnerships in more than 50 countries

Sydney, CBD location

UTS: ENGINEERING AND INFORMATION TECHNOLOGY
# UTS OVERALL RANKINGS

<table>
<thead>
<tr>
<th>Times Higher Education</th>
<th>QS</th>
<th>ARWU (Shanghai Jiaotong)</th>
<th>Excellence in Research Australia (Australian Government)</th>
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<tr>
<td>9&lt;sup&gt;th&lt;/sup&gt; in Australia</td>
<td>9&lt;sup&gt;th&lt;/sup&gt; in Australia</td>
<td>Top 400 overall</td>
<td>94% of UTS research classified as world standard; and 67% of research classified as <em>above</em> world standard</td>
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<tr>
<td>1&lt;sup&gt;st&lt;/sup&gt; in Australia and 21&lt;sup&gt;st&lt;/sup&gt; globally - Top 150 under 50</td>
<td>193&lt;sup&gt;rd&lt;/sup&gt; in the world</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; in Australia and 8&lt;sup&gt;th&lt;/sup&gt; in the world - Top 50 Under 50</td>
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<tr>
<td>46&lt;sup&gt;th&lt;/sup&gt; most international university in the world</td>
<td>QS 5 Stars</td>
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*UTS: ENGINEERING AND INFORMATION TECHNOLOGY*
Top 100 for engineering, technology and computer science in the world—2016 ARWU subject fields (the other four Australian Universities are UNSW, Melbourne, Monash and UQ)

**QS World University Subject Rankings**

> Top 100 for computer science and information systems

> Top 150 for electrical & electronic, civil and structural, and mechanical and manufacturing engineering
UTS RESEARCH FOCUS AREA: DATA SCIENCE

Data science is the multidisciplinary science of capturing, storing, retrieving, analysing and communicating information, and turning it into a valuable resource, recognising and promoting ethics, privacy, security and social justice considerations.

Learn more about UTS research in data science.
FEIT SCHOOLS

The power of FEIT’s teaching and research comes from its 6 Schools and associated Research Centres:

> School of Biomedical Engineering (launching in 2017)
> School of Civil and Environmental Engineering
> School of Computing & Communications
> School of Electrical Mechanical and Mechatronic Systems
> School of Software
> School of Systems Management and Leadership
KEY FEIT RESEARCH FOCUS AREAS

Research focus:

- Advanced Analytics
- Artificial Intelligence
- Autonomous Systems
- Built and Smart Infrastructure
- Computational Intelligence and Brain Computer Interface
- Energy Policy
- Global Big Data Technologies including 5G and Photonics
- Green Energy and Vehicle Innovation
- Health Technologies
- Quantum Software and Information
- Technology in Water and Wastewater
- Transport
Facilities include: 3D immersive Data Arena, specialist labs, Software Development Studios and Industry Engagement Hubs.
A 360-degree interactive data visualisation facility set to change the way we view and interact with data
Our Research Strengths

School Research Strategy

- Centre for Artificial Intelligence
- Centre for Quantum Software and Information
- Advanced Analytics Institute (AAi)

- ~80 academic/research staff
- > 200 PhD students
- Research areas include: Data analytics, Artificial Intelligence, Machine Learning, Robotics, Software Engineering and Interaction Design
### SOFTWARE – REPRESENTATIVE PROJECTS

<table>
<thead>
<tr>
<th>WATER SECURITY AND INFRASTRUCTURE MANAGEMENT</th>
<th>• Discovering deep insights into value of water for securing the future of regional communities</th>
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</table>
| SOCIAL MEDIA SENTIMENT ANALYSIS             | • Call centre and social media data  
• Correlation and situation analysis  
• Improved policy execution and public perception  
• Advancement of staff participation and morale |
| MARKETING AND THE CUSTOMER                   | • Discovering deep insights into customer retention |
| DATA SCIENCE FACILITIES                      | • 3D immersive Data Arena;  
• specialist labs; and  
• Software Development Studios |
Research Foci

1. Artificial Intelligence (AI)
   focusing on theoretical foundations and innovative technologies for data science, data mining and machine learning, knowledge discovery and decision making; artificial intelligence and image processing

2. Quantum software and information (QSI)
   focusing on fundamental, theoretical research in quantum software
• Spotlight on recent *Data Science* projects with industry (2015-2016):

1. Cohort Discovery and Activity Mining for Policy Impact Prediction (ARC LP16: *Comm. Department of Health*)
2. Interaction Mining for Cyberbullying Detection on Social Networks (ARC LP15: *Australian Research Alliance for Children & Youth; Global Business College of Australia*)
3. Artificial Intelligence (AI) + Smart Home (Industry funding: *BroadLink in China*)
   • AI model for Smart Home Environment management
   • IoVT: AI for Internet of Virtual Things

• Total income: $11.5 Million

Centre for Artificial Intelligence  
**UTS: CAI**
Advanced Analytics Institute – AAi

Client and Behaviour Analytics
• Risk scoring, prevention and prediction
• Improved debt collection
• Enhancement of client engagement

Social Media Sentiment Analysis
• Call centre and social media data
• Correlation and situation analysis
• Improved policy execution and public perception
• Advancement of staff participation and morale

Achievements:
• Research funding over $6 millions in 4 years
• Over 250 A* and other high-impact publications
• International collaborative network with academics, research centres and international professional bodies
• Recognition of thought leadership and excellence in industrial engagement amongst governments, industry and peers.

Analytics Model for Strategic Planning
• Detection of risks and issues
• Facilitation of an evidence-based prioritisation of resources planning
• Improved corporate planning
• Enhancement of staff engagement

Industry Partners
MARKETING AND THE CUSTOMER
DISCOVERING DEEP INSIGHTS INTO CUSTOMER RETENTION

Methodology
- Using explorative analysis, descriptive analysis, pattern mining, investor churn risk scoring, and investor retention predictive analytics

Approaches
- Use explorative and descriptive analysis of available datasets and an existing logistic regression model to understand the data structure and linkage within various data sources, and identify the workflow and mechanism of current churn risk analytics algorithms and limitations.
- Adopt cutting-edge pattern mining algorithms, e.g., factor analysis, correlation analysis, sequence pattern mining, contract pattern mining etc. to capture the discriminative features that impact investor churn behaviour, and the correlations between discovered features
- Investigate how to model advisor/investor relations from advisor/investor behavioural data, e.g., online web transactions and activities, and how to integrate behavioural features into the retention analytics model
- Develop robust and scalable churn risk scoring algorithms by aggregating the various discriminative features, including demographic, behavioural, and temporal factors, and design and implement a user-friendly predictive system for customer retention analysis and decision-support.

Outcomes
- A tested model that is reusable and scalable.
- A basic building block for a future self-learning engine
- Actionable knowledge that will support CFS's stated retention targets and attrition rates.

BUSINESS ENGAGEMENT AND CUSTOMER FEEDBACK
- Solutions and technology have been developed and tested on market data
- Many years of work experience combining advanced technology with financial domain knowledge
- Caters for both technical soundness and business performance of the solutions
MACHINE INTELLIGENCE TO DETERMINE FUTURE INFRASTRUCTURE REQUIREMENTS

**WATER SECURITY AND INFRASTRUCTURE MANAGEMENT**

**DISCOVERING DEEP INSIGHTS INTO VALUE OF WATER FOR SECURING THE FUTURE OF REGIONAL COMMUNITIES**

### Highlights

- First time used to developing a digitised tool for rapidly assessing water security needs of regions of a State in Australia → Irrigation/Drought
- Develop catchment needs assessment indices for regulated and unregulated river systems
- Use advanced data mining and machine learning to identify causes to each region
- To determine economic loss to regions based on economic, health (including environmental) and social factors
- Shift to science based decision making

### Approach

- To develop an effective methodology using advanced analytics and machine learning:
  - to identify ‘Hot Spot’ Areas of water security for river systems and regional town water supplies and to identify the causes using advanced data analytics
  - Rapid analysis tool to for assessing current and future urban water supply and irrigation needs across NSW, including considerations of climate variability, population growth and socio-hydrological and industrial/agricultural changes
- Data from numerous departments: DPI Water, Infrastructure, Town Planning, Economic Development, Health

**MACHINE INTELLIGENCE TO DETERMINE FUTURE INFRASTRUCTURE REQUIREMENTS**
FEIT DATA SCIENCE OVERVIEW – CASE STUDY

We deliver business-driven, innovation-empowered and interdisciplinary expertise. We present high industry adaptability.

Selected high impact research showcase projects – Centre for Autonomous Systems (CAS)
FEIT ACHIEVEMENTS IN DATA SCIENCE AND APPLICATIONS

Food Agility CRC
• >$160 million
• 54 partners from food, technology and research sectors
• UTS collaborators: FEIT, Science, Business

54 signed partners
5 state governments
7 research providers

11 food value chain organisations
3 industry networks
6 representatives of RDCs and regional development

7 service providers
15 technology providers
SUMMARY: AWARD WINNING RESEARCH

- A team led by UTS Adjunct Daniel Catchpoole and Paul Kennedy won the Cancer Institute of NSW: Big Data, Big Impact Grant — Stage 2 as part of the NSW Premier’s Awards for Outstanding Cancer Research ($150k)

- CAS team won 2016 NSW Australian Water Association Research Innovation Award

- A team led by A/Prof Guandong Xu together with Colonial First State has received accolades in two categories of the BigInsights Data Innovation Awards:
  - Best Customer Insights – Winner
  - Best Industry Application of Data Analytics – Highly commended

http://dataawards.org/2016-winners/
The vision of IoT at UTS

Dr Gengfa Fang
Leader of IoT Lab, GBDTC, UTS
gengfa.fang@uts.edu.au

Research Projects
Industrial IoT Projects
Government Sectors
IoT Events
Students and Community

Research Activities
Product Prototyping
Partnerships
IoT Smart Building
Research Centres (GBDTC, CAI)

UTS IoT Demos, Capabilities, Solutions
Areas of IoT@UTS

- Agriculture
- Farming
- Smart City
- Air Conditions
- Green Houses
- Smart Farming
- Energy
- Smart Grid
- Vending
- Environmental
- Food Supply Chain (Food Agility CRC)
- Metering
- Transport (iMove CRC)
- Rail
- Public Transport
- Remote Monitoring
- First Responders
- Road
- Remote Monitoring
- First Responders
## Projects and Research at IoT Lab

<table>
<thead>
<tr>
<th>Projects</th>
<th>Research Strength</th>
<th>Demos</th>
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<tr>
<td>Green, Efficient and User-friendly Building</td>
<td><strong>IoT Wireless Networks</strong>&lt;br&gt;• Ultra low power and low complexity wireless Devices: IoT-NB, LoRaWAN&lt;br&gt;• Smart IoT WiFi/LoRaWAN AP/Gateway&lt;br&gt;• IoT security solution: Communications and networking, and data center etc.&lt;br&gt;• Smart Gateway for IoT&lt;br&gt;• New Communication Schemes for Ultra Low Throughput at 5G&lt;br&gt;• New networking protocols for IoT</td>
<td>• IoT sensors visualization&lt;br&gt;• Air Quality Monitoring&lt;br&gt;• On-demand air conditioning System&lt;br&gt;• Space monitoring and scheduling&lt;br&gt;• Dynamic and Smart Lift</td>
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<tr>
<td>Digital Farming and Supply Chain</td>
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<td>Intelligent Transportation and Roads</td>
<td><strong>IoT Data Analytics</strong>&lt;br&gt;• Edging data analytics&lt;br&gt;• IoT Cloud and data processing&lt;br&gt;• Real-time IoT data processing&lt;br&gt;• Machine learning for credit estimation&lt;br&gt;• AI for autonomous IoT solutions</td>
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<tr>
<td>Distributed and Smart Energy Solution</td>
<td></td>
<td>• Distributed Solar Station Solution&lt;br&gt;• Power Consumption Monitoring&lt;br&gt;• Smart In-door Drones over IoT</td>
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<td>IoT for Banking</td>
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<td>Secured Infrastructure</td>
<td><strong>Data Visualization</strong>&lt;br&gt;• 3D Data Arena</td>
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IoT Smart Engineering Building

Renewables

- Co-generation system
  - solar thermal concentrator panels
- Energy Storage and Distribution
- Wind Turbine
- Photovoltaics Modules and Health Monitoring

Sensors: 3500+

- Rooftop Weather Station
- Concrete Embedded Sensors
- Energy meters:
  - Ventilation, lighting, air-conditioning, equipment
- Internal Environment Sensors
  - O2
  - Nitrogen Dioxide
  - Air Polluants
  - Liquid Petroleum Gas
  - CO2
  - Luminosity
  - Temperature
  - Humidity
  - Sound
  - People counters
UTS-SAS Partnership and IoT Project

Objectives

• To engage in a long-term research partnership
• To develop UTS-SAS IoT Innovation Lab
• To mine and analyze the data in edge devices and end devices
• To design, build and verify customized IoT data stream processing models in data centres and the cloud
• To build real IoT demos of based on UTS Engineering Building with 3000+ sensors with historical and real-time data
Students undertake undergraduate and postgraduate data analytics subjects:

- 31250 Introduction to Data Analytics [u/g]
- 32130 Fundamentals of Data Analytics [p/g]

Around 100 students in each of these subjects running twice a year.

Part of u/g & p/g Data Analytics majors which include choice of 4-5 data analytics based subjects.

Also used in a Business Intelligence subject in the School.
HOW WE USE SAS @ UTS

In 31250/32130

- For past 3 years guest lectures from SAS Australia staff
- Students use SAS Enterprise Miner esp. Decision Trees to support other learning with open source tools, e.g. R or KNIME
- Planned Faculty program: Future Workspace to facilitate student access to SAS – and overcome previous issues of software cost, requirements for open ports on locked down UTS network, and general lag of potential cloud-based approaches.

Also used in other subjects e.g. in Advanced Data Analytics, SAS staff regularly take part in Industry Panel to advise students re: employment.

Main issue limiting further uptake in class: complexity of SAS EntMiner software vs. open source alternatives wrt numbers of options that can be set and in getting data into SAS EM.