Institution:	Goldsmiths, University of London
Unit of Assessment:	11: Computer Science and Informatics
Title of case study:	**SpendInsight**

1. Summary of the impact (indicative maximum 100 words)

Bishop and Danicic contributed to the development of novel spend analysis software. Launched in 2011 as a commercial service by KTP industrial partners @UK PLC, SpendInsight has been used by over 380 organisations, including Basingstoke and North Hampshire NHS Foundation Trust, which, alone, cut procurement spend by £300,000 via savings identified using SpendInsight. An analysis produced by SpendInsight for the National Audit Office identified gross inefficiencies in NHS procurement, yielding potential annual overall savings of at least £500 million**.** The findings of this report were discussed in parliament and changes to NHS purchasing policy were recommended as a result.

2. Underpinning research (indicative maximum 500 words)

Danicic joined Goldsmiths in 2000 as a full-time lecturer and has since been promoted to Senior Lecturer and then Reader. Bishop joined Goldsmiths in 2003 as a Reader and has been promoted to Professor. They have both been here full-time continuously.

In 2006, Goldsmiths and Reading University began working with an SME called *@UK* on three related Knowledge Transfer Partnership (KTP) projects. Goldsmiths' contribution was principally through one of these led by Bishop and Danicic (KTP 1575, 19/07/06 – 31/08/09). The research, which led to the development of the SpendInsight spend analysis system, focused on a central – ontological – problem: how to recognise as the same, entities specified in different ways (for example, how to identify *'BD Plasticpak 50ml syringes'* as equivalent to *'50 millilitre B D Plasticpak syringe'*. The Goldsmiths contribution drew on two long-established departmental research themes: 'machine understanding' and 'formal semantics'.

Bishop has been working on the foundations of machine understanding for many years; his 2002 OUP text, *Views into the Chinese room,*[3] is one of the definitive texts in the field. He is still extremely active in the subject: for example, he recently extended Searle's Chinese room argument from its original, rule-based script systems configuration to one that takes into account the most recent advances in "Quantum linguistics" [4]. This research, stemming from the critique of formal systems and exploring the links between syntax and semantics, informs the work of SpendInsight in its application to the language-understanding problems of: data re-structuring, de-duplication and product classification [1,2]:

- *Data re-structuring* is the problem of taking incomplete differently structured data from many different sources and automatically converting them all into objects of the same well-defined structured schema. The work also draws on Danicic's work on formal *semantics*: re-structuring syntactically different, yet equivalent, structured schemas [5].
- *De-duplication* is the problem of deciding when apparently different entities [in the core 'knowledge structure'] are actually different representations of an 'equivalent entity'. Equivalent entities, although syntactically different, often match the same pattern. Our constructivist approach to this problem, instantiated by a rule-engine in which all rules are applied iteratively until the system stabilises, results in sequentially `cleansed views' of the core knowledge structure (see [1] and [2]). This novel approach grew from discussion of Danicic's work on the detection of 'equivalent mutants' (structures with small syntactic differences; similar to those occurring in the 'knowledge structure') [6] that reported research that was developed in an EPSRC grant (Linear Schemas for Program Dependence EP/E002919/1).
- *Product Classification* denotes the following problem: from a large set of purely textual descriptions of products and the structured data above, we need to find which products could be classed as 'alternatives', i.e. those which are 'semantically equivalent' (the semantic equivalence

of 'syntactically distinct objects' forming the underlying abstraction outlined in [1]).

A novel combination of the 'Decision Tree' and 'Bayesian classifier' algorithms was introduced to solve this classification problem [2]. The textual descriptions for each product are reduced to a "bag of words" and a set of manually classified training data is used to calculate the conditional probability of a word belonging to (a product in) each class.

3. References to the research (indicative maximum of six references)

The international quality of the research is evidenced by publication in selective peer-reviewed journals [1,4,5,6] and publications by respected publishers such as OUP [3].

1. Roberts P, Mitchell RJ, Ruiz V, Bishop JM (2012) Classification in E-Procurement. *Proceedings of the IEEE Conference on Cybernetic Intelligent Systems* (Limerick Ireland); extended version accepted for publication in the *International Journal of Applied Pattern Recognition*.

   [Available on request from the Research Office]

2. Barraclough R, Bishop JM, Danicic S, Nasuto S, Mitchell R (2012) SpendInsight: Some remarks on deploying an intelligent spend-analysis system. *Proceedings of the AISB/IACAP World Congress in honour of Alan Turing*, pp. 1-6. Birmingham, UK.

   [Available on request from the research office]

3. Preston J, Bishop JM (2002) *Views into the Chinese room*. Oxford University Press. ISBN-13: 978-0199252770.

   [Available on request from the Research Office]

4. Bishop JM, Nasuto SJ, Coecke B (2013) 'Quantum linguistics' and Searle's Chinese room argument. *Studies in Applied Philosophical, Epistemological & Rational Ethics*, 5:17-28, Springer.

   [Available on request from the Research Office]

5. Danicic S, Harman M, Hierons RH, Howroyd J, Laurence M (2007) Equivalence of linear, free, liberal, structured program schemas is decidable in polynomial time. *Journal of Theoretical Computer Science*, 373: 1-18. DOI: 10.1093/logcom/14.2.325.

6. Hierons RH, Harman M, Danicic S (1999) Using program slicing to assist in the detection of equivalent mutants. *Journal of Software Testing, Verification and Reliability*, 9(4): 233-262. DOI 10.1.1.26.465

4. Details of the impact (indicative maximum 750 words)

a) SPENDINSIGHT

SpendInsight has had far-reaching and substantial impact on both society and the economy.

The societal impact:

- SpendInsight was used [1] to produce the data for a National Audit Office (NAO) report [2] highlighting gross inefficiencies in NHS procurement.
- The NAO report was discussed by parliamentary committee [3], which recommended changes in Government health policy.
- SpendInsight technology was subsequently used to develop GreenInsight - a system to measure an organisations carbon footprint, reveal which suppliers and goods contribute most to this footprint, and to help create an organisation's carbon reduction plan [4].

The economic impact:

- SpendInsight has produced significant savings for a number of health Trusts.
- SpendInsight is listed on the Government's Procurement Service, a service aiming to increase financial efficiency across the whole UK Public Sector [7].
- SpendInsight technology has been licenced by VISA inc. and Tungsten Corporation resulting in an immediate 500% increase in the value of @UK [10].
- SpendInsight technology has been licensed to Tungsten Corporation significantly contributing to their recent over-subscribed launch on AIM of £233million.
- Following the project, @UK hired the three KTP associates as permanent employees.

The 2011 investigation into the procurement of consumables by the NHS by the National Audit Office revealed huge inefficiencies in NHS trusts' procurement [2]. The task of a carrying out quantitative analysis of data for this was undertaken by @UK PLC using SpendInsight [1]. The findings were published in a 33-page NAO report in February 2011 [2] which identified that:

> *"If hospital trusts were to amalgamate small, ad-hoc orders into larger, less frequent ones, rationalise and standardise product choices and strike committed volume deals across multiple trusts, they could make overall savings* ***of at least £500 million****, around 10 per cent of the total NHS consumables expenditure of £4.6 billion."*

This report was discussed by the House of Commons Committee of Public Accounts in May 2011 [3] which concluded that the Department of Health should require all NHS purchasers and suppliers to make use of a standard, comprehensive product bar-coding system so that price comparisons can easily be made and savings opportunities identified; purchasers must ensure that product bar-coding is in place by April 2014.

The NAO report featured strongly in BBC news [8] and subsequently led to an investigation into health procurement by the BBC radio programme *File On 4* [9], an investigation which focused on the *political impact* of the report and concluded that – in contrast to Conservative party manifesto policy (decentralising budget-holding and commissioning responsibilities to GPs) - money could be saved "*if only trusts could get their act together*".

SpendInsight has so far been used to perform spend analysis for 382 different organisations. Although the data are normally confidential, a number have publicly reported savings: these include the Basingstoke and North Hampshire NHS Foundation Trust (£300,000) [5] and the Royal Berkshire NHS Foundation Trust (£100,000) [6].

SpendInsight is listed on the Government's 'Procurement Service'; an agency of the Cabinet Office supporting procurement across the Public Sector, aiming to increase operational and financial efficiency. Thus SpendInsight is available on a 'national framework contract', making it possible for Public Sector organisations to use the service very easily [7].

The market capitalisation of @UK PLC increased substantially after it announced that, together with Visa Inc., it was rolling out its CloudBuy platform across Asia Pacific using SpendInsight technology to create 'the region's first business-to-business integrated e-marketplace solution'.

Another recent development of SpendInsight technology has seen Tungsten Corporation sign a five-year license for the SpendInsight software; the unique ability of this technology to analyse client spend data at the 'line item level' is central to their corporate vision. On October 16th 2013 Tungsten floated on AIM, the largest floatation on AIM since 2008, closing substantially over offer at £233million [10].

b) GREENINSIGHT

In September 2011 the NHS announced that it would work with @UK PLC on a project using @UK PLC.'s core SpendInsight technology, to develop GreenInsight - a system to measure NHS carbon footprint, reveal which NHS suppliers and goods contribute most to this footprint, and to create a

NHS carbon reduction plan.

GreenInsight's significance has been recognised among leading organisations promoting sustainability. Its official launch (on 7th October 2010) was attended by Richard Benyon, Minister for the Natural Environment and Fisheries, and included a presentation from a member of Prince Charles's *Accounting for Sustainability* project.. When the GreenInsight data-format, Green-XML, was subsequently launched on 15th November 2011 there was a video message from the HRH Prince of Wales, an introduction from the RSA's Chief Executive, and a presentation from the CEO of the worldwide benchmark emissions reporting programme, the Carbon Disclosure Project [10].

5. Sources to corroborate the impact (indicative maximum of 10 references)

All the materials listed below are available on request, in hard or electronic format, from Goldsmiths Research Office.

1. Professional Outsourcing Magazine (highlighting that SpendInsight software was used to compile the NAO report: NHS procurement needs improving.

   (http://professionaloutsourcingmagazine.net/news/nao-nhs-procurement-needs-improving)

2. 'The Procurement of consumables by NHS acute and Foundation trusts, Executive Report by the Comptroller and Auditor General of the National Audit Office, published 2 February 2011. ISBN: 9780102969467

   (http://www.nao.org.uk/report/the-procurement-of-consumables-by-nhs-acute-and-foundation-trusts/)

3. House of Commons Committee of Public Accounts, Formal Minutes Session 2010–12

   (http://www.publications.parliament.uk/pa/cm201012/cmselect/cmpubacc/875/875.pdf)

4. The launch of GreenInsight and Green-XML £300,000 savings realised by Basingstoke and North Hampshire NHS Foundation Trust (registration required to view): Procurement in NHS Trusts is "poor value for money" says NAO report.

   (http://www.uk-plc.net/green-marketplace-launch-7th-october.html)

   (http://www.publictechnology.net/sector/nhs-health/procurement-nhs-trusts-poor-value-money-says-nao-report)

5. £100,000 savings realised by Royal Berkshire NHS Foundation Trust

   (http://assets-production.govstore.service.gov.uk/Giii%20Attachments/@UK%20PLC/Bids/SpendInsight%20Royal%20Berkshire%20NHS%20Foundation%20Trust%20Case%20Study.pdf)

7. Link to @UK PLC featured on Government Buying Solutions website: Government Procurement Service website.

   (http://www.buyingsolutions.gov.uk/catalogue/service.html?supplier_id=910&contract_id=707)

8. BBC News Health

   (http://www.bbc.co.uk/news/health-12338984)

9. File on 4 Report (discussing impact of NAO report)

   (http://www.bbc.co.uk/programmes/b0150phx)

10. The SpendInsight Project

    (http://sebastian.doc.gold.ac.uk/spendinsight/)