IfM Distributed Information and Automation Laboratory

UNIVERSITY OF CAMBRIDGE

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Welcome from Professor Duncan McFarlane:

Uncertainty, Risk and Resilience (URR)

The notion of "steady-state" operations seems to be increasingly a notion of the past in these times of continual change and frequent disruption.

These issues – of interest to DIAL since 1995 – are being now examined within a department-wide initiative on the role of engineering in addressing uncertainty, risk and resilience. Academic interest in this area ranges from uncertainty modelling of mechanical systems right through to resilience analysis of a national long term automotive sector. In 2013 there will be a series of workshops on URR, a number of industrial projects exploring aspects of industrial resilience and development of an operational resilience auditing tool. More to follow....

In this issue we introduce another of our industrial collaborators, James Hyde, Operations Director at Six Works Ltd as well as reporting on projects and events underway in DIAL.

DIAL's PhD student Zhenglin Liang on his research into the maintenance of complex assets

Business continuity and prosperity are critical for industrial companies. Both of them are highly dependent on whether companies can keep improving the performance of their production. This implies a requirement for high availability of industrial assets. The difficulty in contemporary industrial assets is that they tend to be complex and integrated by multiple function units. Maintenance for such complex assets is problematic, especially when a functional unit malfunctions and becomes the source of problems which affects its interacting units.

Zhenglin Liang is a second year PhD student under the supervision of Dr Ajith Parlikad. He is currently researching the topic of modelling the complex deteriorating behaviour of assets with regards to the interdependence of functional units within the assets, such as the fault developing and propagating processes in power transformers. He also works on optimization of hybrid maintenance regimes for complex assets in terms of availability and operational cost.

Meet DIAL's new Research Associate: Phil Catton

Dr Phil Catton joined DIAL in November 2012 as a Research Associate. He graduated from Brunel University's System Engineering Department with a BEng in Manufacturing Engineering, before pursuing research in condition monitoring and inspection

using low frequency ultrasound. He was awarded an EngD from The University of Surrey and Brunel in 2008 for his research into novel signal processing methods capable of accurately determining the dimensions of defects in oil and gas pipeline. He then continued his research at TWI Ltd (an engineering consultancy who supported his EngD) while leading European research projects, developing software, hardware and the British Standard (BS9690) for pipeline inspection. Phil then joined the Brunel Innovation Centre as a Research Fellow, where his research investigated the use of ultrasonic vibrations to clean industrial process pipes.

He is now a member of the CSIC Core team, and is working on projects involving asset management, sensor networks and information management.

Meet DIAL's visitor: Sergiu Guta

Sergiu Guta joined DIAL in January 2013 as a student visitor from the University Politehnica of Bucharest, Faculty of Automatic Control and Computers. He graduated from the University of Craiova with a Bachelor degree in Economic Informatics and a Masters degree in International Business Administration.

During his visit, from January 2013 to April 2013, Sergiu will be working with Professor Duncan McFarlane to investigate the use of agent technology in leather manufacturing processes. His research activity will concentrate on developing a multi-agent system for leather processing monitoring and quality control.

Warehouses in China – from third party warehousing to third party supply chain management provider

According to the China Economic Census in 2012, the profit margin of 2.6% for warehousing business remains the lowest compared to other businesses within the logistics industry, such as 12.45% for transportation providers and 8% for loading/unloading providers. In order to improve the profit margin, value-added services have become increasingly popular topics for third party warehousing companies.

The concept of value-added services is equivalent to the concept of "value-adding partnership" that Russell and Paul reviewed in Harvard Business Review in 1988. In their review article, the concept was described as "a set of independent companies that work closely together to manage the flow of goods and services along the entire value-added chain". According to third party warehousing companies, the value-added services will not only include traditional service areas such as kitting, packaging, palletising or labelling, but also trying to extend to supply-chain management solutions such as post-order assembly, asset management or inventory management.

With these potential value-added services, the warehouse operations will be more diverse and consequently more complex to manage with the current warehouse management system, which is only passively recording data of orders and inventories. Therefore warehouse companies are now seeking to implement advanced management systems that might proactively and intelligently interact with the operations. Hence some research opportunities are foreseen, for instance:

- What would be the framework or implementation approach of an intelligent management system flexible enough to suit different combinations of operations or services?
- Would the concept of the 'Internet of Things' or the 'Intelligent Product' play an important role?

Wenrong Lu
DIAL PhD Candidate

Congratulations to Dr. Borek

Congratulations to Dr. Alex Borek on the successful completion of his PhD. Alex's research on "A risk based model and process for quantifying the business impact of information quality" was supervised by Dr. Ajith Parlikad and funded by the EPSRC. Alex will soon start working with IBM at their offices at London Southbank. We wish him the very best for the future!

Hitachi funds research in fault diagnostics

DIAL has kicked off a new research project in fault diagnosis and data management funded by Hitachi

Europe Ltd. The objectives of this 18-month project are to develop:

- A through-life fault-data management approach.
- An incident management system to support maintenance personnel in diagnosing faults in key sub-systems on Hitachi trains.

For further information, contact Dr. Ajith Parlikad.

The European 2012 Data Management and Information Quality conference

The European 2012 Data Management and Information Quality conference was co-located with the Data Warehouse and Business Intelligence conference in London. The conference was therefore very broad and covered all the essential topics for the data management professional. With people from all over the world in attendance, it was a magnificent networking opportunity.

The latest state of the practice for information management technologies were presented at the conference by some of the top thought leaders in the area. Big data, master data management (MDM), data virtualisation, data warehouse implementations, and methods for assessing and improving information quality were among the many hot topics discussed.

Alexander Borek and Dr Philip Woodall, from DIAL, were invited to present their work on information risks. They presented a new method for quantifying information risks (that arise from information quality problems) and showed how these can affect the business. Several consultants were interested in the approach and were keen to adopt the process.

Product Intelligence & Smart Warehousing

Six eCommerce Fulfilment works with online retailers to help them fulfil online orders, by offering a pick and pack service over the cloud. Goods are stored in a central warehouse which is in turn managed by cloud software enabling real-time data exchange between stores, packers and clients.

We have solved and further improved a number of issues present in the warehousing industry with regard to data caching and non-real time transfers, but more ingrained is the lack of information flow within the warehouse itself. Many of the decisions that need to be made each day are in principle very simple, but when multiplied up to thousands of activities and products become impossible to solve. Product Intelligence offers a new way of optimising these multi-dependency decisions and we hope it will enable us to run more efficiently as well as reduce the lead time from product delivery to order despatch.

For example, the biggest problems by far are deciding which orders to pack - where there is a trade off between efficient pick routes and order priority - and deciding where to store inventory so as to enable optimised pick routes and storage. The use of Product Intelligence for us would mean that we let each order or each product decide what it wants to do (based on its requirements and needs). In each case this would allow us to make decisions in a short time frame - something which, given the number of variables and possibilities, is not currently possible.

Shelves would know about their own dimensions and their current space availability to be able to flag themselves as appropriate options to products. Products themselves would be able to know their own size, what other products they are likely to be ordered with (and where these are currently stored), how often they will be purchased and whether they have special storage requirements; before choosing an optimal storage location.

Orders already know about their priority and how long they have been queued in the system, but

they would need an awareness of other similar orders and where products could be found to optimise picking routes. Decisions here may seem trivial, but there are many conflicting interests in the warehouse. There is a real danger that a system which prioritises efficiency may leave behind an order which requires a slow moving product which is off the best route, creating delays. So any intelligence needs to consider the time of day, warehouse work rate and any back-log before making decisions.

James Hyde
Operations Director, Six Works Ltd

Linked Data and the Semantic Web

Mark Harrison recently gave a seminar to researchers in DIAL and the Cambridge Service Alliance about Linked Data and Semantic Web technology.

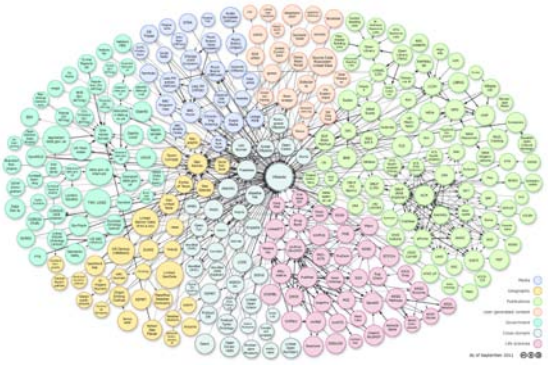
We hear a lot about 'Big Data' - but what about 'Linked Data' and 'Open Data'? It turns out that Linked Data technologies such as Resource Description Framework (RDF) and the SPARQL RDF Query Language provide some very useful tools for exploring Big Data, while Open Data provides many useful public datasets that we can mash-up with our internal corporate big data, in order to make better use of it.

We have recently been using Linked Data / Semantic Web tools in a couple of our research projects, both to look at ways of more effectively integrating and managing enterprise data from different sources (including data from suppliers and customers), as well as tackling the challenge of sharing commercially sensitive information (such as serial-level traceability information) across supply chains, where we need fine-grained access control to determine who should be allowed to see some specific data, especially when there are many intermediate organizations between the information requestor and the information provider.

The World Wide Web (WWW) is a global collection of documents (web pages) with hyperlinks that link one document to a related document. Search engines periodically crawl the web, following links to discover new web pages and rank these.

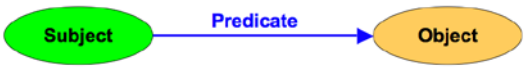
Web pages are primarily designed for consumption by human beings, who can usually extract the information they require and understand the context and semantic meaning of the content, regardless of how it is presented in the page. However, computers do not yet have this ability and therefore need assistance (in the form of semantic markup) in order to 'understand' the information that is presented in a web page or document and make meaningful comparisons across different datasets or websites.

Linked Data allows individual 'facts' to be expressed in a machine-readable format and even embedded within a web page. This means that the world wide web becomes not only a network of linked documents but a global distributed database. In fact, Wikipedia has a linked data counterpart called DBpedia, which contains the fact and figures that appear in the 'info boxes', of Wikipedia web pages. DBpedia is certainly not alone and there is an ever expanding 'Linked Open Data Cloud' of available open data, including geographic information, government statistics (e.g. crime statistics, government expenditure, etc.).



Linking Open Data cloud diagram, by Richard Cyganiak and Anja Jentzsch. http://lod-cloud.net

The 'facts' are expressed as RDF triples, which are simple logical 'sentences' that relate a subject to an object via a predicate (property relationship).



URIs are used to uniquely identify not only web pages but also people, places, things, relationships and abstract concepts. For example, the URI:

```
http://dbpedia.org/resource/Paris
```

is a URI identifier in DBpedia for the capital of France and provides RDF triples representing facts and figures about Paris. One of these is a statement that:

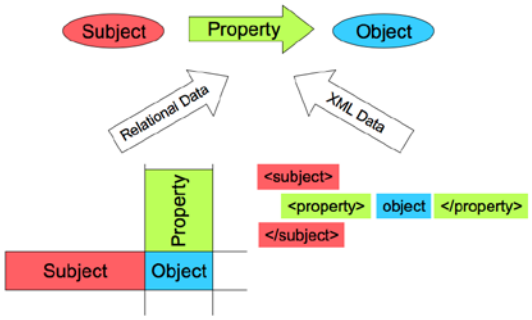
```
http://dbpedia.org/resource/Paris
http://www.w3.org/2002/07/owl#sameAs
http://sws.geonames.org/2988507 .
```

i.e. additional facts and figures about Paris can be found in the GeoNames linked data for the URI identifier:

```
http://sws.geonames.org/2988507
```

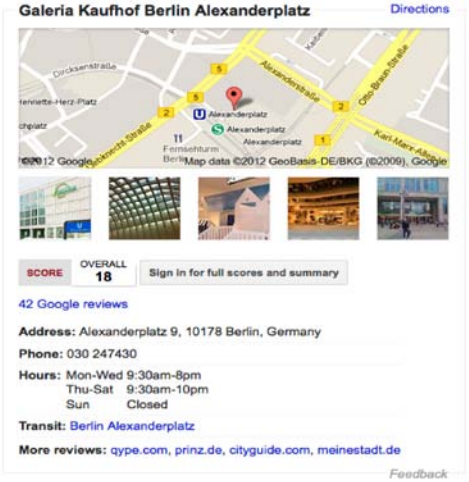
Linked Data is therefore a large 'graph' of inter-connected data, consisting of nodes (things) and arcs (relationships), provided by multiple contributors including individuals, government agencies.

The same tools can also be used within the enterprise to make it much easier to integrate data from multiple heterogeneous sources, since RDF provides a 'lowest common denominator' format for expressing the factual information, while ensuring that the meaning of each piece of data is correctly preserved.



The SPARQL RDF query language supports federated queries, allowing you to combine data from multiple sources (e.g. combine internal data with public open data) to discover new insights. It also allows you to chain predicates (property relationships) together in queries to discover how things are related to each other. Linked Data tools are even being used in life sciences research to discovery new pharmaceuticals to treat diseases by exploring the end-to-end connected knowledge fragmented across several research papers about the connections between genetic sequences, proteins, receptors and the biochemical activity of active pharmaceutical ingredients.

Companies who use linked data markup in their web pages are already being rewarded with enhanced search engine result listings (see for example Google Rich Snippets), which can provide a product image or location map of a business, key specifications, opening hours, travel directions etc.



The schema.org and GoodRelations ontologies provide a de facto standard set of terms that companies can use right now to describe their products and services in this way.

A presentation with further information is available at **http://tinyurl.com/DIAL-LinkedData**

Upcoming DIAL Seminars

Ivian Casali Duarte (University of Espirito Santo, Brazil), "Carbon Emission – A General approach to road freight transportation", IfM Seminar Room 3, 7th February 2013, 14:00 – 15:00.

Barry O'Brien (ARUP), IfM Seminar Room 3, 28th February 2013, 14:00 – 15:00.

Torben Jess (DIAL), IfM Seminar Room 3, 11th April 2013, 14:00 – 15:00.

JiaQiang Wang (DIAL), IfM Seminar Room 3, 18th April 2013, 14:00 – 15:00.

Sergiu Guta (Politehnica University Bucharest), IfM Seminar Room 2, 25th April 2013, 14:00 – 15:00.

If you are interested in anything that has been featured in the newsletter or would like further information about DIAL, then please do not hesitate to contact us on dial-enquiries@eng.cam.ac.uk or call Petra Kasmanova on +44 (0)1223 764306.

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