A team of researchers from Computing Science Department does IHPC proud by clinching second place in the DSM Challenge that match-makes data analytics with real-world sales forecasting.

The DSM Challenge is a competition that involves using 2011 and 2012 data from DSM Engineering Plastics, a Dutch company which supplies high-performance engineering thermoplastic solutions, to predict monthly sales figures for 2013 and beyond. It was part of the Data Innovation Challenge held under the auspices of the IDA.

A total of 311 submissions were received from both local and international teams, of which six teams made the cut for the final round.

Dr Duan Rubing said: “The challenges were to build predictive models for sales predictions, based on various data sets from DSM. We already had the capability to manage different data sets and to design various analytic predictive models. However, the competition also requires the understanding of DSM’s business models and the influencing factors in the market.”

Leveraging on existing capabilities in IHPC’s Distributed Computing capability group, the IHPC team managed to leapfrog the tough field to clinch second place.

It was no easy task.

“The most challenging part was how to apply and combine different models to fit the DSM business scenarios.”

Rubing added: “We spent about seven days on this competition, sometimes working during week-ends and after office hours due to the tight deadline.”

To the team members, the award is testament that IHPC’s modelling and simulation capabilities is not only sufficiently mature to solve problems of industrial interest, but also competitive when ranked against other computing organisations.

The team took part in the competition for the opportunity to “apply our capability to domain specific problems that are beneficial to the industry.”

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It was most definitely a team effort.

Team leader Rubing designed the models for the data sets, solved major technical issues and gave the final presentation to the judges. Wang Long, as a key member, implemented some models on different scenarios and contributed immensely to the project.

Dr Li Xiaorong, as the main founder of the team, gave strong support and provided vital advice on the modeling segments.

Rubing said: “Her advice was the key element of this achievement.”

The rest of the team attended the discussions and contributed their expertise on the models.

“We are very glad that our capability works well in this competition. It was done in quite a short time frame for us. Through this competition, we sought to improve our skills, build up the relationships with potential partners in the industry, and apply our work in a commercial environment.”

The team is raring to go for future competitions.

Rubing said: “We will be selective to join in the competitions and give the highest priority to those which are in line with the capabilities that we are building. We hope to gain more experience to help industry partners, including MNCs and local SMEs.”

In the meantime, there is no time for rest as the team gears up for further development.

“The developed predictive model will be enhanced and it is possible to be integrated into our scalable computing platform to provide online service in the future.”

The confidence gained is palpable, and has boosted the team’s morale.

Rubing said: “This Data Innovation Challenge achievement proves that IHPC’s modelling and computing capabilities are very promising and competitive, and can be successfully applied to business sectors to add value to companies.”

IHPC Happenings

A*STAR-LR Ideas Forum

IHPC hosted the inaugural Ideas Forum in October 2013, which was organised by the A*STAR – Lloyd’s Register (LR) Working Committee. Close to 40 researchers and staff from both A*STAR and LR attended this event, which was held at Infuse. There were lively interactions among the participants, and the forum created more opportunities for A*STAR research institutes and LR researchers to exchange ideas and explore R&D collaboration opportunities in the marine, energy and offshore sectors. The Working Committee plans to organise regular Ideas Forums for researchers to gather and explore new project ideas.
Hawker Centres and Cooking Up Heated Discussions

Dr. Poh Hee Joo from FD Department gave a talk titled “Application of Computational Fluid Dynamics modelling for ventilation design in Hawker Centres: Case study presentation of a few hawker centres”. He was one of the guest presenters at the NEA Distinguished Speakers Forum held at the end of October.

The crux of the matter: Thermal discomfort in naturally ventilated hawker centres, especially within the context of Singapore weather which is hot and humid throughout the year, had posed a great challenge to architects and Mechanical and Electrical (M&E) consultants in designing comfortable dining environments for hawker centre patrons.

Hee Joo shared a few hawker centre case studies in Singapore which utilised high performance computing-based CFD (Computational Fluid Dynamics) simulation tools to verify and improve the design of ventilation systems. The CFD modelling work takes into consideration the heat load from kitchen stoves, heat release from customers, typical winds, and kitchen hood operations.

Computer predictions for the air flow and temperature fields were systematically investigated by solving the transport phenomena mathematical equations governing fluid flow and heat transfer, through numerical iteration procedures.

Results showed that there are generally four important factors affecting thermal comfort in Singapore hawker centres, namely:

- The properties of the roof materials that are subjected to radiation heat transfer
- The architectural strategy of the roof top shape
- The number, and the orientation, of the fans
- The hood exhaust capacity.

The research findings came from a collaboration project between IHPC and M&E consultants from local contractors and consultancy firms to study the thermal comfort conditions in the hawker centres.

IHPC at Cloud Expo Asia

A team of researchers from Computing Science Department’s Distributed Computing team were at Cloud Expo Asia to network and promote IHPC’s cloud capabilities. The event was held at the Suntec Exhibition Centre over two days in November. There were many enthusiastic visitors and the team were kept busy answering queries and explaining IHPC’s cloud offerings for enterprises.

Two IHPC researchers also gave presentations during the Expo that offered insights on different aspects of cloud technologies.

Dr. Terence Hung, IHPC’s Deputy Executive Director, gave an overview speech titled ‘Cloud for Science, Industry and Beyond’ at the Big Data and Analytics Theatre.

Dr Li Xiaorong, Senior Scientist and Capability Group Manager, spoke on ‘A holistic modelling and optimization approach for improving energy efficiency in large-scale cloud data center’ at the Data Centre Infrastructure, Operations and Facilities Management Theatre.

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Techventure 2013

IHPC researchers were present at the Techventure 2013 event held over two days in September 2013. The event was designed to bring together venture capitalists, angel investors, innovators and aspiring tech entrepreneurs.

A team of Computing Science researchers, comprising of Huynh Phung Huynh, Mian Lu, Ong Zhong Liang, Rick Goh, and Huynh Tung, exhibited a demo of their web portal, fiuzu.com, that helps travellers to plan their trips according to their customised preferences and budgets – an A.I. travel agent of sorts, thanks to data analytics.

Said Dr. Huynh Phung Huynh: “We had a great experience at Techventure, hosting more than 100 visitors at our booth. We were kept on our toes as we introduced fiuzu to them and gauged their interest and gained feedback on how we could do better. It was also the first opportunity we had to gain a first-hand experience on the technology ecosystem in Singapore.”

The team has built a simple prototype of the fiuzu trip planner, and are now actively building the next-generation travel guide to allow users to have an easily navigable, centralised source of structured and organised information on their destination.

On the roadmap ahead: The development of a fully automated personalized trip generator that can automatically collect a user’s travel preference, crawl and process data, and finally generate a personalised trip using fiuzu’s intelligent and deep-learning capability.

Huynh added: “If we solve the issues well, fiuzu will save a significant amount of time and money for independent travellers when it comes to planning their personalised trip. Through fiuzu, we expect to develop new cutting-edge technologies in the area of highly accurate, high performance and highly scalable data analytics.

Dr. Jason Png, director of Electronics and Photonics department, led another team of researchers to showcase the Optic2Connect technology, which leverages on IHPC’s expertise in electronics and photonics, to provide patented solutions that bring data transmission technologies to new heights.

Jason said: “Imagine the possibilities if you could download a blu-ray disc in less than one second, or battle it out in the high-definition graphics of World of Warcraft with zero lag time!”

Along with improvements in technology, the volume of data transmission has been increasing exponentially.

But current transmission practices – using electrical systems to transmit data – are facing difficulties in keeping pace with the need for faster transfers at greater volumes, as well as with providing adequate storage options for the amount of data that is currently being transmitted.

Jason added: “Optic2Connect provides a solution by exploring optics as a scalable means of data transfer. In particular, it examines the usages of photons and electrons instead of just electrons to receive and send data.”

A software, aptly named AccuMap, has been developed to capture data bit by bit, and this is further supported by another application called AccuSpeed, which then accurately maps the data connections between the electronics and photonics systems.

Essentially, this creates a seamless bridge for up-down conversion of data that maximises the efficiency of data transfer.

Jason explained: “This photonics system uses silicon as a transmission medium, and therein lies the beauty of it all. Because silicon is the material presently used as a platform for current electronics data transmission, the fabrication cost for photonic devices drops phenomenally, as the technological know-how to manufacture the devices is already in place.”

According to the team, the potential for Optic2Connect is enormous – there may come a day when inter-chip connections in all communication devices, from mobile phones to computers to data centres, operate on this technology, and this will change the face of the communications industry.

Being in the entrepreneurial seat, says Jason, forces scientists to think about how high technology is intricately linked to enterprise, and how their research can become commercialised to meet business needs.

“Our participation at Techventure 2013 was highly beneficial. Meeting up with potential partners, customers and investors gave the team multiple ideas in making the technology more viable so that it meets the needs of the industry.”

(From left) Dr Rick Goh, Dr Lim Soon Thor, Dr Jason Png and Dr Terence Hung.

(From left) the fiuzu.com team: Huynh Tung, Dr Mian Lu, Dr Huynh Phung Huynh, Dr Rick Goh and Ong Zhong Liang.

(From left) the Optic2Connect team: Dr Jason Png and Dr Terence Hung.
Singapore is home to a thriving marine and offshore industry. Blessed with a critical location at the confluence of major shipping lanes, the Singapore marine industry has long been a leading centre for shipping, repairing, designing and building of marine vessels and offshore structures. In recent years, the offshore sector has seen an unprecedented boom, largely driven by the strong demand for global deep water oil and gas exploration/production. This is a long term demand with many technical challenges and high value added engineering requirements, Singapore hopes to build on its growth momentum to invest in these new capabilities to preposition the industry for the future.

Driven by national initiative, we have developed strong capabilities in the field of modeling and simulations pertinent to maritime, offshore and ocean engineering. As part of the efforts, we have established a Joint Lab with Southampton Marine and Maritime Institute (SMMI) of University of Southampton (UoS), with A*STAR funding support for four years, starting from 1 October 2013.

The collaboration of the IHPC-SMMI Joint Lab aims to build on strengths of Singapore and UoS to establish long term strategic research partnership and develop capabilities and knowledge for the marine and offshore sector.

The joint-lab is located in IHPC, where several academic professors from SMMI will work with researchers from Singapore on different collaborative projects. At the first phase, we have finalised four projects, two of which focus on floating platform hydrodynamics and the other two are on structure and material research, involving SMMI, NUS and IHPC researchers. Some projects on corrosion are also under discussion now.

As an initial public activity of the Joint Lab, a workshop was recently held at Infuse Theatre on 28 November 2013, jointly organised by A*STAR, IHPC, and SMMI. The objectives of this Joint Lab workshop were:

- To introduce the IHPC-SMMI Joint Lab with focus on:
  - Fluid-structure interactions and computational fluid dynamics;
  - Structures and materials mechanics; and
  - Corrosion and surface engineering.
- To report the development and flagship projects progress; and
- To seek inputs from industry and academic communities.

The Joint Lab workshop was well-received by academia and industries. Some industry collaborators have expressed interest to get involved in the current projects and provided insightful and critical suggestions to four ongoing projects. Industries are also willing to contribute to the Joint-Lab projects by providing data, and form joint industry projects.

(Above) Dr Lou Jing, Director of Fluid Dynamics Department giving an overview introduction at the workshop.
Dr Keith Foo leads the Soft Matter capability group in IHPC’s Engineering Mechanics (EM) Department. Powering Discoveries sits him down for a chat about his work and more.

**What is Soft Matter and why is it an important R&D area in engineering?**

Soft matter research deals with the study of materials that can be easily found in biological systems and daily life. Examples include elastomers, gels, and muscles. As an emerging field, it plays an increasingly important role in commercial applications and new technologies. However, these materials behave fundamentally differently from traditional engineering materials. The research in this field is still at a relatively nascent stage.

**What is life like as the capability group manager, leading the Soft Matter team?**

It has been an honour, and a challenge at the same time, to lead a team that comprises some of our most experienced and senior scientists in the Institute. My job has been made easier by the fact that I’m surrounded by a group of very capable and talented scientists, who are committed to develop our core capabilities for the Institute.

**What do you see as your team’s mission?**

The key mission of the Soft Matter Group is to develop theoretical models and simulation tools, so that we can understand the mechanical behaviour of soft materials, which may be used in engineering and biomedical applications.

**What are some challenges your team is facing?**

One challenge is to establish strategic collaborative links with the industry. We are constantly thinking on how we can apply our developed capabilities and know-how to be relevant and attractive for our collaborators, be it academia or industry, both locally and globally. We are also mindful of the need to promote our research and cooperate with other stakeholders, so that our research benefits the society.

**How do you think you can overcome these challenges?**

We are actively looking to raise awareness for our expertise and showcase our research, so that we can increase the opportunities for engagement. Besides constantly engaging our partners through dialogues and workshops, I think social media and personal websites could be useful to showcase our work and raise the visibility of the group.

**How did you end up pursuing a career in research?**

When I was an undergraduate at NTU, I attended a talk by A*STAR about a Pre-Graduate Scholarship. The scholarship offered financial support for my undergraduate studies and monthly allowances. It was attractive and I always thought I wanted to be a scientist, so I applied for it.
Q: When did you realise that R&D was a career worth pursuing?

A: While doing my PhD, I was spending almost all waking hours thinking of ideas, running simulations, and writing my dissertation – at the expense of spending time on other things that are important to me as well, such as my family and friends. It was then I realised how much I enjoyed research and wanted to be successful at it.

Q: What was it like to have done your post-doctoral fellowship at Harvard?

A: It was an eye-opening and enriching experience to work in one of the top universities in the world. I witnessed firsthand how they do research and collaborate in a fast-paced and exciting environment. Harvard is where I expanded my skill sets very quickly and learned to do good work. The stint also gave me more confidence, to know that I can interact and work with some of the smartest people who come from around the world. Finally, I must add that I am very grateful for the support from A*STAR Graduate Academy and the management at IHPC, which made this all possible.

Q: Now that you’re back at IHPC, what are your thoughts on working in A*STAR?

A: I am very excited and I look forward to contribute to the research in A*STAR. I am also relishing the challenge of establishing our team as a group doing important work on modelling and simulation for soft materials in the region.

Q: What do you enjoy most about working at IHPC?

A: I like that we have flexibility to work on projects that are impactful and meaningful to us, so long as our work is aligned with the strategic directions of the Institute. I also appreciate the support from my colleagues and department, as well as the management and administration.

Q: Away from work, how do you relax and recharge?

A: I run to take my mind off work. I find that my best ideas come to me after a good run and also in the shower. Recently, my wife and I have a new baby boy. So now, I am his designated playmate!

(Edited: Congratulations, Keith!)
Land use planning can be regarded as a resource allocation problem where land is allocated to and classified under various use types, such as residential, commercial and industrial. This allotment arises from the competition for limited resources among city planners, property developers, entrepreneurs and inhabitants. The individual land use constituents collectively and directly impact city level dynamics. For instance, city transportation networks are partially dependent on the activity-based traveling behavior of citizens as determined by their respective locations of origins (e.g. residential areas) and destinations (e.g. employment areas). Similarly, the energy grid and ecosystem services hinge on the flows of energy and financial assets that are, again, dependent on land use design. There are more examples of significant city constituents that are intricately linked with existing land use, ranging from waste management to water distribution, and even telecommunication structures.

Land use optimisation, especially in the Singapore context, continues to be a focal point in developing sustainable and resilient cities that can mitigate undesirable phenomena such as overcrowding, traffic jams, and air and noise pollutions. To meet the challenges posed by rapid urbanisation, ageing population, energy cost, environmental constraints, among others, a way to quantify the similarity and difference of existing land allocations among cities is essential. Such measures may allow comparison on the quality of life and general wellness of the residing population; hence, a step closer towards achieving an objective metric for properly representing a city’s sustainability index.

Our team from the Complex Systems (CxSy) group at IHPC’s Computing Science Department has recently demonstrated that by combining the relative mixing of distinct entities (business, residential, industrial) in a given administrative region and how they are relatively spread over the area, one can quantify the degree of similarity and distinctiveness of land design attributes of cities.

In particular, we have developed a procedure using spatial entropy and index of dissimilarity to capture the distinctness of the dispersion and aggregation forces between land use types. Spatial entropy looks at how a given sector (business, residential or industrial) is spread across a given space, and thus provides a measure of the general aggregation tendency of a specific sector. The lower the entropy, the more aggregated a given sector is. There is an advantage in numbers (or in aggregating), but only to a certain extent that it does not compromise the resources needed by a specific sector due to limited land area.

Index of dissimilarity, on the other hand, is a measure of the relative mixing of sectors. Such a metric is critical in defining the efficiency of different urban fabrics, especially transportation and energy consumption. Such a measure, we conjecture, can be a proxy to the infrastructure of a given city.

We have shown that the combination of these two parameters provides a straightforward means of probing the common and unique attributes of Singapore and other North American cities. For example, our method has shown that the common feature of most cities is for the industrial areas to be highly clustered while at the same time segregated from the residential or business districts. We have also established that the combination of entropy of residential and dissimilarity index between residential and business areas provide a quantitative and potentially useful means of differentiating land use patterns of different cities (see Figure 1).

Figure 1: Quantifying cities based on entropy $S$ and dissimilarity index $D$. Industrial sectors are highly clustered (low $S$) and at the same time well-segregated (high $D$) from the residential and business sectors.
The method developed has also captured the detail that newer cities like Las Vegas and Houston, which are cities of the automobile age with hardly any public transport, display a bigger spread of business activities than the older East Coast cities like New York and some Canadian cities like Vancouver and Toronto.

We also found that in a planned city-state such as Singapore, the ranges over which activities segregate or cluster are much larger than those for more organically grown cities. Planning control is thus likely to destroy natural patterns, as implied by the comparison of these measures for Singapore with those for North American cities.

One of the challenges that we are facing in this study (and this is generic to the field), is that city size definitions are highly variable and the maps that we have sourced to develop this work are not chosen with the best boundary definitions in mind, largely because we have no control over these. This suggests that we should develop further research along comparative lines, which deals with different political, cultural and developmental regimes with respect to such urban patterns.

Inspired by the above results, we have also created a model that combines the two opposing forces of dispersion and aggregation, and imposing actual land use constraints (i.e. defining non-developable lands), to reconstruct the spatial emergence of land use of Singapore as well as other Northern American cities (see Figures 2 and 3). Simultaneous recovery of six independently measured attributes (entropies and relative mixing of residential, business and industrial sectors) from only three parameters (aggregation sizes of the three aforementioned sectors) point at the robustness and statistical accuracy of our constructed paradigm. Additionally, we have shown that a single growth seed emanating from the centre of a pre-defined central business district can sufficiently produce, in all the simulated cities, a remarkable resemblance with actual land use patterns.

Our team is optimistic that this seminal work will yield simple growth models that define patterns of different urban activities that can be traced to a small, simple and parsimonious set of key physical parameters.

Figure 2: The Singapore land-use model. Starting from a pre-defined seed assumed to be at the centre of mass of the central business district, the model dynamics proceed by a combination of dispersion and aggregation limited by non-developable land use constraints. Highlighted in the right are the areas that remain (yellow colour) after non-developable lands are removed.

Figure 3: Comparison of the actual land use and the simulated land use emergence. The above results are possible realisations from the model described in Figure 2.

Sources:


*corresponding author

Notes:

1. The work has been previously featured in: http://www.research.a-star.edu.sg/research/6749
2. A simulation of the emergence of Singapore’s land use can be viewed in the supplementary material of [2] or in the CxSy website (http://www.ihpc.a-star.edu.sg/cxsy/land-use.php).
3. The article that will appear in PlosOne [2] is done in collaboration with Prof. Michael Batty, Chair of CASA-UCL, Fellow of the British Academy. He has been awarded the prestigious Lauréat Prix International de Géographie VautrinLud, the highest award that can be gained in the field of geography.
The IHPC Annual Dinner was a heartening showcase of hidden talents at IHPC. For the second time, we had our very own colleagues belting out tunes, playing musical instruments and dancing with grace and poise, facilitated by our very own emcee, Billy Teo.

Our IHPC staff spent countless hours weekly rehearsing hard for the final moment. We had our very own directors playing and singing for us (Su Yi and Rick from Computing Science, Sharon from Corporate Services, Sridhar from Engineering Mechanics and Jason from Electronics & Photonics), and our ED Professor Alfred Huan capped it off with a soulful rendition of “Peng You” by Alan Tam for the night.

Of course, we would not be able to forget Dinda, Zhaoxia, Suwit and Mayling for their touching vocals, saving all their love for the evening and making the night rock like Titanic; Sebastian for his powerful guitar solo; as well as Kayo, Iris and Freda for their fantastic flamenco dance; and last but not least, Robin for his beautiful harmonica solo.

Our Annual Dinner would not have been possible without the combined effort of the IHPC Social Committee Members as well as the staff performers. A big thank you goes out to the Social Committee members who spent hours planning and putting everything together; as well as our wonderful colleagues who participated so sportingly; without everyone’s presence, the dinner would not have been possible. It was a memorable night for all in IHPC.
First HPC Academy Course Graduation

A**CRC designed and conducted the HPC Academy Course from 28 February to 13 June 2013. 36 students from A*STAR, NUS, NTU, NEA and other institutions have completed this specially-designed course. The course consisted of ten 3-hour lectures and eight workshops, delivered by the software team of A**CRC and faculty staff from IUUC (Illinois University at Urbana-Champaign), NTU and NAG.

The topics covered include introduction of HPC, parallel programming models including MPI, OpenMP, Charm++ and CUDA; debugging and performance optimisation tools such as ddt and MAP, and the use of Netlib and NAG numerical libraries.

The graduation ceremony took place on 5 September 2013 and was attended by most of the graduates. Dr Marek T Michalewicz, Senior Director of A**CRC awarded the graduates the certificates issued by IUUC and A**CRC.

The second edition of HPC Academy will be offered from February to April 2014. Professor Yuefan Deng, visiting A**CRC from the Applied Mathematics Department at Stony Brook University, will teach the course, with hands-on and tutorials run by A**CRC software staff.

Look out for more details on the A**CRC website http://www.acrc.a-star.edu.sg

Memorandum of Understanding for A**CRC-Intel Centre of Excellence

Intel and A**CRC signed a Memorandum of Understanding (MoU) to establish the Centre of Excellence for Xeon Phi Computing Lab in October.

By Marek Michalewicz
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According to the agreement, Intel will provide two SGI Servers with Xeon E5 Ivy Bridge and Xeon Phi. Intel will train A**CRC staff on software tools such as compilers, debuggers, libraries and parallel programming on Xeon Phi hardware. A**CRC will gain advanced information on several areas, including:

• Roadmap for Haswell and Broadwell platforms
• Knight Landing roadmap
• Interconnect and Fabric roadmaps
• Lustre, iCAS and other software tools

Intel, together with SGI, will be the local partners to scale the training and support, while A**CRC key staff will develop academic and training programs for students and utilize the Parallel Computing Lab for hands on training with Xeon Phi.

With support from Intel, A**CRC is planning to develop and host an annual parallel programming contest to enable new applications on Xeon Phi on a national scale. The competition will involve participants from A**STAR and institutes of higher learning in Singapore.
Big On Big Data!

The IHPC Student Seminar on Big Data attempted to help students and teachers make sense out of big numbers in raw data.

In a data crunching mood, over 250 students and some teachers attended the IHPC Student Seminar titled ‘Big On Big Data.’ The event in August 2013 at the Genexis Theatre within Fusionopolis served to introduce various aspects of the hot topic, Big Data, that is poised to change the way we view and understand the world.

IHPC’s Dr. Erika Legara and Henry Kassim from Computing Science department gave a gentle introduction to Big Data, and provided an example of how big data analytics, powered by high-performance computing (HPC) technologies, can help to predict the impact of public transport disruptions on the MRT network.

Mr Chan Chi Loong from VslashR, a data visualisation company, spoke on how to translate big data insights into visual diagrams and charts that help people to understand the underlying trends better.

Assistant Professor Justin Dauwels from NTU’s School of Electrical and Electronic Engineering, presented on various big data-related projects on this small island – including understanding Singapore’s traffic patterns, diving into neuro-engineering through analyzing large chunks of brain data, and even social robotics.

Mr Harish Pillay, IT industry veteran and Red Hat evangelist, spoke on ‘Big Data – Why Should I Care?’, and went on to give valid reasons to care. He also used anonymous data collected from the students via a special online survey conducted before the Seminar, to illustrate how researchers can extrapolate trends from collections of raw data.

The Big Data Seminar ended with a Q&A session, with all the speakers given an opportunity to address certain questions on Big Data through the Pigeonhole Live online system.