Research Highlight 1: Multi-agent based Ship Traffic Simulation System for the Singapore Strait: Design and Implementation Objective, by Research Engineer Gao Song (Track Leader: Professor MENG Qiang)

Objective

In order to analyze the impacts of large ships on the navigational accident risk in the Straits of Malacca and Singapore (SOMS), a multi-agent based ship traffic simulation framework is established. The modular architecture consists of a navigation scenario modelling module, a vessel generation module, a rule-based ship traffic simulation kernel and the navigational accident risk assessment module, supplemented by visualization components and an import function for geographical data (based on QGIS). The simulation system is the foundation for accident risk assessment of future marine traffic for SOMS. The system simulates the activities of ship navigating in the Singapore Strait based on the traffic demand entered by the user and generates motion trajectory data to provide support for collision risk analysis and capacity analysis.

Navigation Scenario Modelling

A ship travelling on the sea need some data support to decide the route of it. The most important data is Seabed data, water depth determines where the ship can go. Although the Traffic Separation Scheme (TSS) defines the waterway boundaries, seabed data is still important for different ships due to different draft. So the system need to supply the information of depth to the ships (agents). TSS is a vector data in the system, and it just defines the boundaries of area ships need navigation in. In fact, TSS consists of 15 polygons. And Raster map of Singapore area is a Satellite image from online open source map, and Satellite image is mainly to give users more intuitive experience.

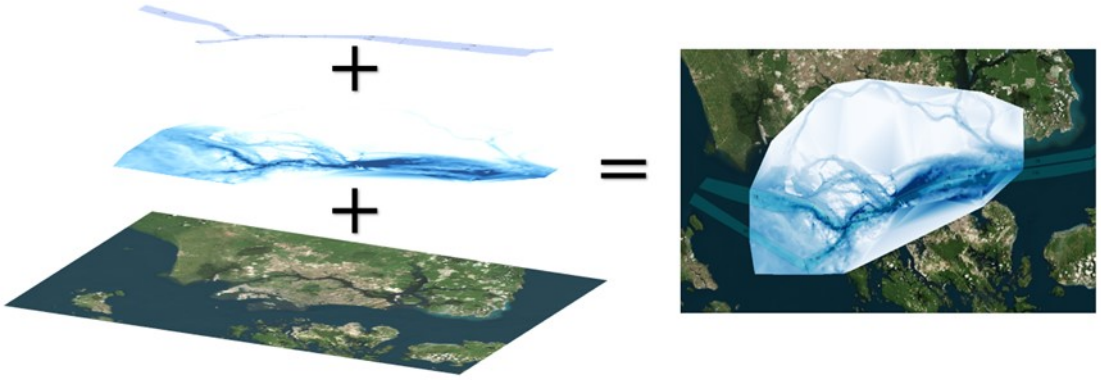

Figure 1. Integrate all the data in system

Since the Singapore Strait is a restricted water area, ships need strict navigation rules in the channel to avoid grounding and collision risk. The blue areas (figure 2) are channel for Traffic Separation Scheme. We define the path (called "link" in the system, because of it links two different destination zone) of ships with a series of waypoints and "gatelines". Waypoint is the turn position of vessel on the route or path, and "gateline" with a left and right width that are decided by actually ships trajectory. Through this design can adapt to any size and shape of the channel.

A ship navigates through the strait may dock multiple destination zones, the system defined the ship's route as a "zone - link" chains. A ship starts from the first zone navigates follow the "link" that with many waypoints. When it arrived at the next zone, it will stay for a period of time, and then leave to the zone and navigates to the next zone follow next link. It repeats this process until the ship arrived at the last zone on the route.

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Navigation Scenario Modelling

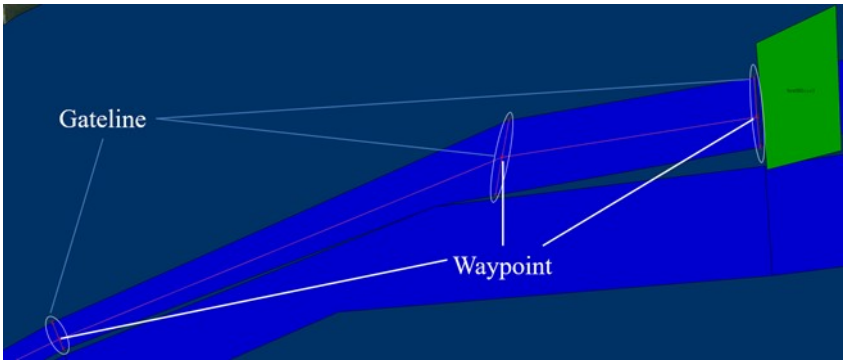

Figure 2. The definition of link

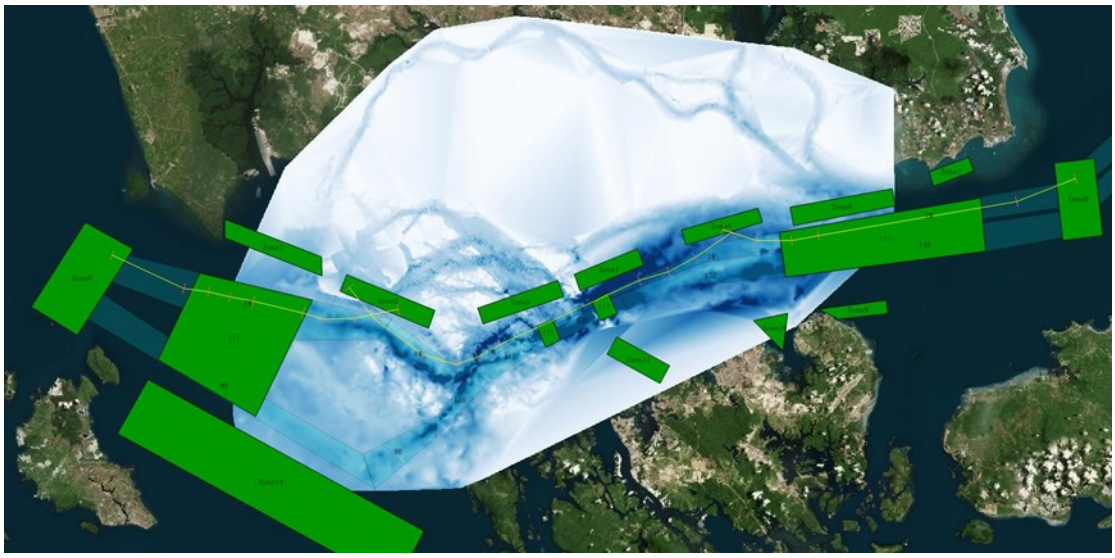

Figure 3. The definition of route in the system

Agent-based ship traffic simulation kernel

The main process flow of ship traffic simulation kernel are as figure 4 shows: firstly, the system reads the user-defined ship traffic demand from the project file, and then generates the ships using the algorithm that mentioned in section 5.1, and puts the ship objects into a "ships pool". The system gets the ship from the pool if ship's spawn time has arrived, and puts that ship into an "active ship list"; secondly, system gets the ship from "active ship list" one by one and executes the ship navigation algorithm, makes a decision, transits the state and takes the action (move the ship object base on ship dynamic model) according to the defined rules, for example, rules of collision avoidance; finally, if the simulation time is over, then the system simulation process will stop and will save the virtual AIS data into a file with CSV format.

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Navigation Scenario Modelling

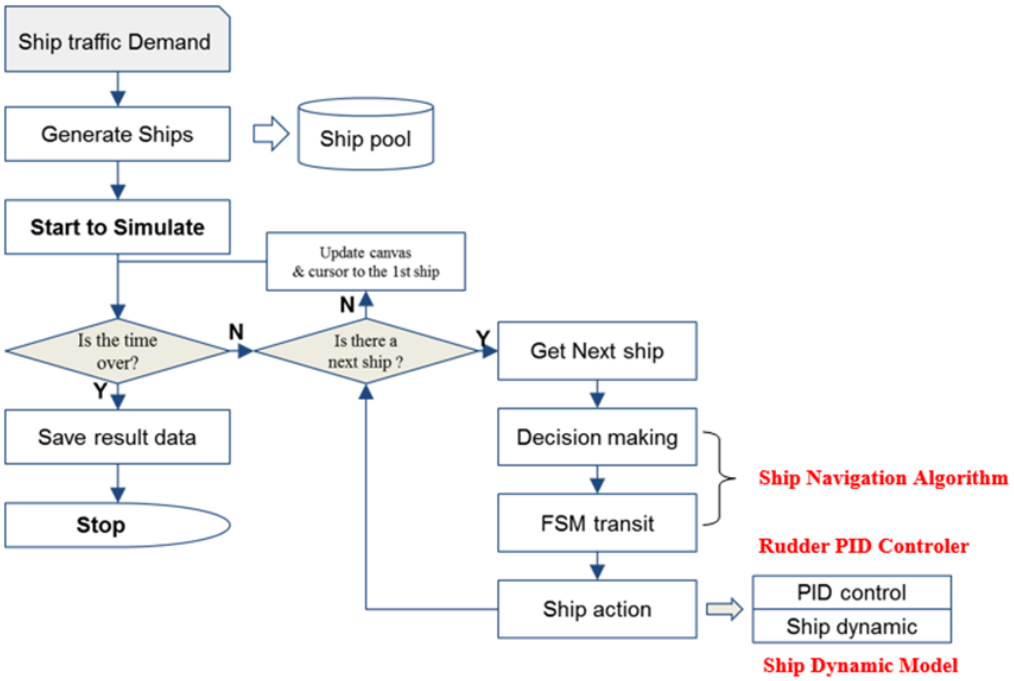

Figure 4. The main process flow of ship traffic simulation kernel

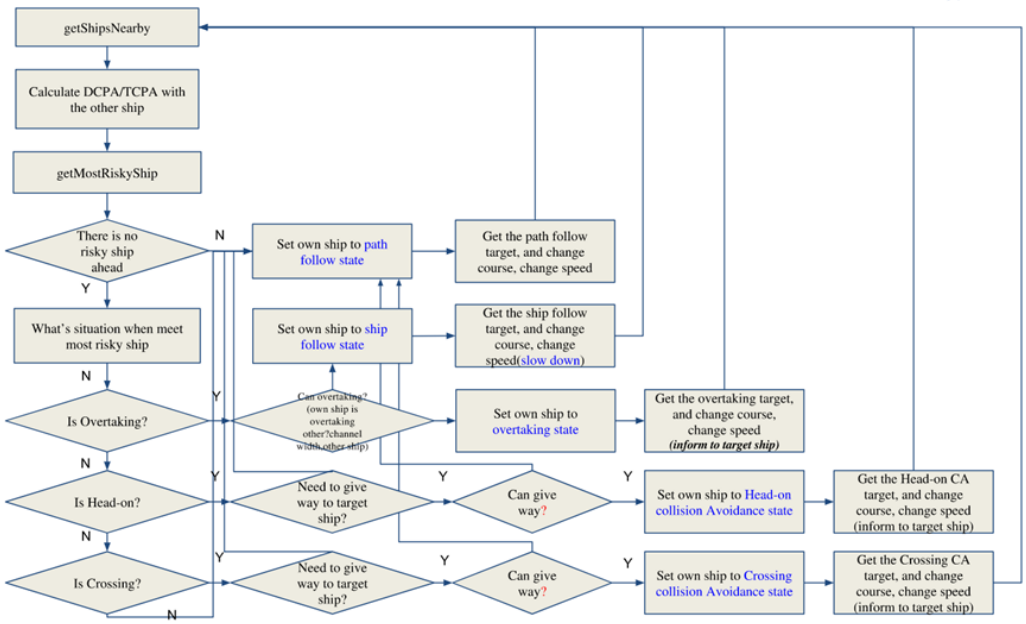

Figure 5. Ship navigation algorithm

Research Highlight 1: Multi-agent based Ship Traffic Simulation System for the Singapore Strait: Design and Implementation Objective, by Research Engineer Gao Song (Track Leader: Professor MENG Qiang)

Navigation Scenario Modelling

The Ship Navigation Algorithm (collision avoidance) figure 5 shows, mainly include follow steps:

1. get the other ships around;
2. calculate DCPA/TCPA to the other ship;
3. get the riskiest ship;
4. judge the bear angle and decide whether into the status of overtaking, crossing or head-on, or just follow the way-points;
5. transit to the new state if it is necessary and calculate the target point;
6. get the desire heading and engine thrust that needed.

System Implementation

The system implements by Python language based on QGIS platform.

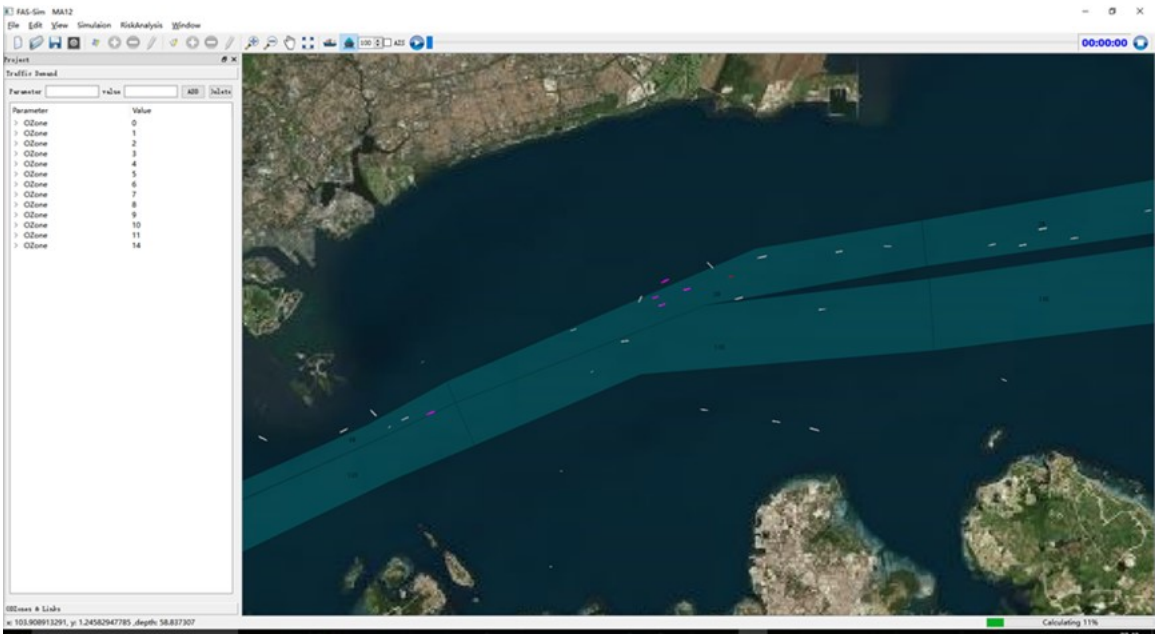

Figure 6. Main GUI of the simulation system

Published Technical Papers (with Abstracts)

1. **Tian Goh and BW Ang (2018), Tracking economy-wide energy efficiency using LMDI: approach and practices.** ***Energy Efficiency, Pages 1-19.***

Abstract:

Various national and international agencies have developed and reported accounting systems to track progress in energy efficiency improvements. Most of these energy efficiency accounting systems (EEAS) are based on index decomposition analysis and the logarithmic mean Divisia index (LMDI) has emerged as the main decomposition method used. We discuss the fundamentals of LMDI with specific reference to energy efficiency analysis and its application to national EEAS development. The main design dimensions and elements of an EEAS are explained. The flexibility of the LMDI approach has allowed analysts and national agencies to tailor the EEAS to suit their national needs and policy purposes. We conduct a literature survey of the implemented and proposed EEAS and summarise their key features. In view of its growing importance, the extension of the EEAS to an energy-related emissions accounting system to track progress towards climate mitigation targets is introduced. Finally, the strengths and limitations of an LMDI-based EEAS for the tracking of energy efficiency trends are discussed.

2. **Tian Goh, BW Ang, Bin Su and H Wang (2018), Drivers of stagnating global carbon intensity of electricity and the way forward.** ***Energy Policy, Volume 113, Pages 149-156.***

Abstract:

Despite the signing of the Paris climate agreement, there is still great uncertainty regarding the world's ability to decarbonize and meet the 2 °C target. In this regard, the electricity production sector deserves particular attention. The sector has the largest decarbonization potential and its share of the world's CO2 emissions from fuel combustion increased from 30% in 1990 to 36% in 2014. To better understand global trends, this study analyses the factors influencing changes in the global aggregate carbon intensity (ACI) of electricity, a measure of the level of CO2 emissions per unit of electricity produced, over the last 25 years using multidimensional index decomposition analysis. It finds that global ACI barely improved since 1990 because of a shift in electricity production from developed to developing countries with higher ACIs. This geographical shift offset consistent improvements to power generation efficiency worldwide and is likely to persist in the future. To keep the 2 °C target realisable, it is imperative to enhance international cooperation to lower the ACIs of emerging economies and deepen the penetration of renewables, which have thus far performed below expectations.

3. **Tian Goh and BW Ang (2018), Quantifying CO 2 emission reductions from renewables and nuclear energy–Some paradoxes.** ***Energy Policy, Volume 113, Pages 651-662.***

Abstract:

As countries seek to adopt cleaner energy sources, a key question that is often asked is what the avoided emissions from the switch to non-fossil based energy sources are. There is no standard approach to tackle this problem. The most common approach, which is known as the primary energy equivalent (PEE) approach, estimates emission reductions by computing the amount of CO2 emissions that would have been emitted from fossil fuels had renewables or nuclear energy not been used. Another approach, the Equal Share (ES) approach, estimates emission reductions based on the change in the share of non-fossil based energy. As the two approaches have some limitations, a more comprehensive approach based on index decomposition analysis (IDA) is proposed as an alternative, together with an extension to quantify substitution amongst non-fossil based sources. A comparison of the assumptions and features of all three approaches is presented. The study finds that IDA is favoured for its ability to identify policy intervention areas beyond a switch to cleaner energy and is well-suited for tracking of progress towards emission reduction targets and analysing future scenarios.

Published Technical Papers (with Abstracts)

4. **Ngurah Agus Sanjaya Er, Mouhamadou Lamine Ba, Talel Abdessalem and Stéphane Bressan (2017), Set of tuples expansion by example with reliability.** ***International Journal of Web Information Systems, Volume 13, Issue 4, Pages 425-444.***

Abstract:

Purpose

This paper aims to focus on the design of algorithms and techniques for an effective set expansion. A tool that finds and extracts candidate sets of tuples from the World Wide Web was designed and implemented. For instance, when a given user provides <Indonesia, Jakarta, Indonesian Rupiah>, <China, Beijing, Yuan Renminbi>, <Canada, Ottawa, Canadian Dollar> as seeds, our system returns tuples composed of countries with their corresponding capital cities and currency names constructed from content extracted from Web pages retrieved.

Design/methodology/approach

The seeds are used to query a search engine and to retrieve relevant Web pages. The seeds are also used to infer wrappers from the retrieved pages. The wrappers, in turn, are used to extract candidates. The Web pages, wrappers, seeds and candidates, as well as their relationships, are vertices and edges of a heterogeneous graph. Several options for ranking candidates from PageRank to truth finding algorithms were evaluated and compared. Remarkably, all vertices are ranked, thus providing an integrated approach to not only answer direct set expansion questions but also find the most relevant pages to expand a given set of seeds.

Findings

The experimental results show that leveraging the truth finding algorithm can indeed improve the level of confidence in the extracted candidates and the sources.

Originality/value

Current approaches on set expansion mostly support sets of atomic data expansion. This idea can be extended to the sets of tuples and extract relation instances from the Web given a handful set of tuple seeds. A truth finding algorithm is also incorporated into the approach and it is shown that it can improve the confidence level in the ranking of both candidates and sources in set of tuples expansion.

5. **Seeram Ramakrishna, Tong-Yi Zhang, Wen-Cong Lu, Quan Qian, Jonathan Sze Choong Low, Jeremy Heiarii Ronald Yune, Daren Zong Loong Tan, Stéphane Bressan, Stefano Sanvito and Surya R Kalidindi (2018), Materials informatics.** ***Journal of Intelligent Manufacturing, Pages 1-20.***

Abstract:

Materials informatics employs techniques, tools, and theories drawn from the emerging fields of data science, internet, computer science and engineering, and digital technologies to the materials science and engineering to accelerate materials, products and manufacturing innovations. Manufacturing is transforming into shorter design cycles, mass customization, on-demand production, and sustainable products. Additive manufacturing or 3D printing is a popular example of such a trend. However, the success of this manufacturing transformation is critically dependent on the availability of suitable materials and of data on invertible processing–structure–property–performance life cycle linkages of materials. Experience suggests that the material development cycle, i.e. the time to develop and deploy new material, generally exceeds the product design and development cycle. Hence, there is a need to accelerate materials innovation in order to keep up with product and manufacturing innovations. This is a major challenge considering the hundreds of thousands of materials and processes, and the huge amount of data on microstructure, composition, properties, and functional, environmental, and economic performance of materials. Moreover, the data sharing culture among the materials community is sparse. Materials informatics is key to the

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necessary transformation in product design and manufacturing. Through the association of material and information sciences, the emerging field of materials informatics proposes to computationally mine and analyze large ensembles of experimental and modeling datasets efficiently and cost effectively and to deliver core materials knowledge in user-friendly ways to the designers of materials and products, and to the manufacturers. This paper reviews the various developments in materials informatics and how it facilitates materials innovation by way of specific examples.

6. **Hongtao Chi, Giulia Pedrielli, Szu Hui Ng, Thomas Kister and Stéphane Bressan (2018), A framework for real-time monitoring of energy efficiency of marine vessels.** ***Energy, Volume 145, Pages 246-260.***

Abstract:

Sea shipping is one of the most widespread transport modes. Therefore, the improvement of energy efficiency and further curbing of Carbon Dioxide emissions by marine vessels is important both economically and environmentally. During the sixty ninth Marine Environment Protection Committee session in April 2016, the International Maritime Organization approved mandatory requirements for ships to report their fuel consumption, which is the first of the three-phase approach to derive a standardized measure for energy efficiency tracking of marine vessels. Under the International Maritime Organization Data Collection System, emphasis has been placed on verification of the collected fuel consumption data so that vessels' energy efficiency could be benchmarked and improved. To optimize the operational efficiency of marine vessels, this paper proposes the Real-Time Energy Efficiency Operating Index and the framework to implement it. The proposed scheme can be used to verify fuel consumption and carbon dioxide emission data reported by individual ships. It also provides an approach to automatically and remotely estimate the transport work in real time. The proposed architecture mainly relies on the Automated Identification System and a constructed vessel database. A proof of concept prototype is deployed that monitors the energy efficiency of vessels along the Singapore Strait.

7. **Mohammad Reza Afshar, Yagub Alipouri, Mohammad Hassan Sebt and Weng Tat Chan (2017), A type-2 fuzzy set model for contractor prequalification.** ***Automation in Construction, Volume 84, Pages 356-366.***

Abstract:

Prequalification helps decision makers find the right contractor for the job, which is key to the successful delivery of a construction project. The procedure involves judging the suitability, capability and competency of the contractor on various criteria, using both anecdotal and empirical evidence. The evidence used is often imprecise and subjective, and so is the evaluation and decision making procedure. Type-1 fuzzy sets have been used in the prequalification procedure to handle uncertain information. However, type-1 fuzzy sets are unable to reflect the differences in opinion among experts involved in group decision making. The purpose of this paper is to propose a practical prequalification procedure that uses interval type-2 fuzzy sets to address both linguistic imprecision and differences of opinion. A numerical example shows how the proposed procedure is carried out and the benefits that result compared to a similar procedure using type-1 fuzzy sets.

8. **Sarah Cheah and Shenghui Wang (2017), Big data-driven business model innovation by traditional industries in the Chinese economy.** ***Journal of Chinese Economic and Foreign Trade Studies, Volume 10.***

Abstract:

Purpose: This study aims to construct mechanisms of big data-driven business model innovation from the market, strategic and economic perspectives and core logic of business model innovation. Design/methodology/approach:

Published Technical Papers (with Abstracts)

The authors applied deductive reasoning and case analysis method on manufacturing firms in China to validate the mechanisms. Findings: The authors have developed an integrated framework to deduce the elements of big data-driven business model innovation. The framework comprises three elements: perspectives, business model processes and big data-driven business model innovations. As we apply the framework on to three Chinese companies, it is evident that the mechanisms of business model innovation based on big data is a progressive and dynamic process. Research limitations/implications: The case sample is relatively small, which is a typical trade-off in qualitative research. Practical implications: A robust infrastructure that seamlessly integrates internet of things, front-end customer systems and back-end production systems is pivotal for companies. The management has to ensure its organization structure, climate and human resources are well prepared for the transformation. Social implications: When provided with a convenient crowdsourcing platform to provide feedback and witness their suggestions being implemented, users are more likely to share insights about their use experience. Originality/value: Extant studies of big data and business model innovation remain disparate. By adding a new dimension of intellectual and economic resource to the resource-based view, this paper posits an important link between big data and business model innovation. In addition, this study has contributed to the theoretical lens of value by contextualizing the value components of a business model and providing an integrated framework.

9. **Haobin Li, Chenhao Zhou, Byung Kwon Lee, Loo Hay Lee, Ek Peng Chew and Rick Siow Mong Goh (2017), Capacity Planning for Mega Container Terminals with Multi-Objective and Multi-Fidelity Simulation Optimization.** ***IISE Transactions, Volume 49, Issue 9, Pages 849-862.***

Abstract:

Container terminals play a significant role as representative logistics facilities for contemporary trades by handling outbound, inbound, and transshipment containers to and from the sea (shipping liners) and the hinterland (consignees). Capacity planning is a fundamental decision process when constructing, expanding, or renovating a container terminal to meet demand, and the outcome of this planning is typically represented in terms of configurations of resources (e.g., the numbers of quay cranes, yard cranes, and vehicles), which enables the container flows to satisfy a high service level for vessels (e.g., berth-on-arrivals). This study presents a decision-making process that optimizes the capacity planning of large-scale container terminals. Advanced simulation-based optimization algorithms, such as Multi-Objective Multi-Fidelity Optimization with Ordinal Transformation and Optimal Sampling (MO-MO2TOS), Multi-Objective Optimal Computing Budget Allocation (MOCBA), and Multi-Objective Convergent Optimization via Most-Promising-Area Stochastic Search (MO-COMPASS), were employed to formulate and optimally solve the large-scale multi-objective problem with multi-fidelity simulation models. Various simulation results are compared with one another in terms of the capacities over different resource configurations to understand the effect of various parameter settings on optimal capacity across the algorithms.

10. **Yuan Wang, Ruyan Shou, Loo Hay Lee and Ek Peng Chew (2017), A case study on sample average approximation method for stochastic supply chain network design problem.** ***Frontiers of Engineering Management, Volume 4, Issue 3, Pages 338-347.***

Abstract:

This study aims to solve a typical long-term strategic decision problem on supply chain network design with consideration to uncertain demands. Existing methods for these problems are either deterministic or limited in scale. We analyze the impact of uncertainty on demand based on actual large data from industrial companies.Deterministic equivalent model with nonanticipativity constraints, branch-and-fix coordination, sample average approximation(SAA) with Bayesian bootstrap, and Latin hypercube sampling were adopted to analyze stochastic demands. A computational study of supply chain network with front-ends in Europe and back-ends in Asia is presented to highlight the importance of stochastic factors in these problems and the efficiency of our proposed solution approach.

Published Technical Papers (with Abstracts)

11. Haobin Li, Loo Hay Lee, Ek Peng Chew and Chun-Hung Chen (2017), GO-POLARS: A Steerable Stochastic Search on the Strength of Hyperspherical Coordinates. ***IEEE Transactions on Automatic Control, Volume 62, Issue 12, Pages 6458-6465.***

Abstract:

Search algorithms for optimizing a complex problem are mainly categorized as gradient-driven and stochastic search, each with its advantages and shortcomings. A newly developed algorithm, GO-POLARS, is proposed with a hyperspherical coordinate framework, which could perturb a given direction with well-controlled variation. It designs a steerable stochastic search algorithm that explores toward a promising direction, such as the gradient, at any desired levels. In this note, we provide an analytical study on the hyperspherical coordinates and the corresponding random distributions and, thus, prove the local convergence property of the GO-POLARS. Extensive numerical experiments are illustrated to show its advantages compared to conventional search algorithms.

12. Lu Zhen, Zhe Liang, Dan Zhuge, Loo Hay Lee and Ek Peng Chew (2017), Daily berth planning in a tidal port with channel flow control. ***Transportation Research Part B: Methodological, Volume 106, Pages 193-217.***

Abstract:

This paper studies an operational-level berth allocation and quay crane assignment problem (daily berth planning) considering tides and channel flow control constraints. An integer programming model is proposed for this problem. Then a column generation solution approach is developed on a set partitioning based reformulation of the original model. Computational study is conducted on 30 test cases constructed from real-world data to validate efficiency of the proposed solution approach. Results show that this simple but practical solution approach can optimally solve the daily berthing planning problem instances with up to 80 vessels, 40 berths, and 120 quay cranes within one hour, which is reasonable and acceptable for the real-world applications. The proposed decision model and the solution approach could be potentially useful for some tidal ports with (or without) navigation channels.

13. Byung Kwon Lee, Loo Hay Lee and Ek Peng Chew (2018), Analysis on high throughput layout of container yards. ***International Journal of Production Research, Pages 1-20.***

Abstract:

The operational efficiency of handling resources plays an important role in promoting container flows at a container terminal. As these handling resources operate on specific yard layouts, a well-designed layout will promote the performance of the handling activities. This study aims to discuss a design process to maximise the throughput capacity, as well as minimise the resource configuration when designing the yard layout. Various experiments were conducted and analysed to demonstrate the effects on the layout structure and the resource configuration for the two types of parallel yard layouts: the double-lane yard layout where vehicles can access the block at both side and the single-lane yard layout where two adjacent blocks in a row are grouped together and vehicles can access each block at only one side. According to the findings, the container flows by vehicles exert greater influence on the design of a container yard compared to the time taken for container processing by quay cranes and yard cranes. It is also found that the single-lane yard layout is preferable when high throughput capacity is required, whereas the double-lane yard layout is superior in favour of high efficiency of vehicle flows.

14. Juxin Li, Weizhi Liu, Giulia Pedrielli, Loo Hay Lee and Ek Peng Chew (2017), Optimal Computing Budget Allocation to Select the Non-dominated Systems-a Large Deviations Perspective. ***IEEE Transactions on Automatic Control, Pages 1-1.***

Abstract:

Published Technical Papers (with Abstracts)

We consider the optimal computing budget allocation problem to select the non-dominated systems on finite sets under a stochastic multi-objective Ranking & Selection setting. This problem has been addressed in the settings of correct selection guarantee when all the systems have normally distributed objectives with no correlation within solutions. We revisit this problem from a large deviation perspective and present a mathematically robust formulation that maximizes the lower bound of the rate function of the probability of false selection (P(FS)). The proposed formulation allows general distributions with sampling correlations across performance measures. Three budget allocation strategies are proposed. One is guaranteed to attain the global optimum of the lower bound of the rate function but has high computational cost. Therefore, a heuristic is proposed to save computational resources. Finally, for the case of normally distributed objectives, a computationally efficient procedure is proposed. Numerical experiments illustrate the significant improvements of the proposed strategies over others regarding the rate function of P(FS).

15. Yingzhu Li, Xunpeng Shi and Bin Su (2017), Economic, social and environmental impacts of fuel subsidies: A revisit of Malaysia. ***Energy Policy, Volume 110, Pages 51-61.***

Abstract:

Subsidizing energy has been widely used but is economically unfavorable. The Malaysian government has shown strong intention to reduce energy subsidies recently, but face challenges to prepare policy instruments to manage the impact. This study develops a Computable General Equilibrium (CGE) model with breakdown of households by income level to evaluate the potential impacts of removing energy subsidies on the Malaysian economy. It is shown that removing petroleum and gas subsidy would improve economic efficiency and increase GDP up to 0.65%. Budget deficit would be largely reduced after removing the petroleum subsidies, especially when the saved subsidy cost is not budgeted for other expenditure. Households would be worse off in most scenarios due to higher price level, but some compensation policy could make the lowest income group no worse than baseline, without harm the economy. The reduction in carbon emissions ranges 1.84–6.63% in different scenarios. The simulation results suggest Malaysia to completely remove all fuel subsidies and use the saved funding to cut budget deficit or spend on education, health and other service sector. It is also necessary to set a compensation scheme to minimize public resistance and make sure such scheme is affordable.

16. Yingzhu Li and Bin Su (2017), The impacts of carbon pricing on coastal megacities: A CGE analysis of Singapore. ***Journal of Cleaner Production, Volume 165, Pages 1239-1248.***

Abstract:

Pricing carbon is a widely used policy instrument for climate change mitigation. Quantitative analysis of carbon pricing are mainly conducted at the regional and national level, rarely at the city level due to data availability. As a representative of coastal megacities that are vulnerable to both climate change and climate policies, Singapore has announced to impose carbon tax on large direct emitters as a complementary mitigation option to technical measures. A city-level Computable General Equilibrium (CGE) model is developed to simulate potential impacts of carbon pricing on the city, including paying border-carbon-adjustment (BCA) on exports or introducing a domestic carbon tax. Different sector coverages and carbon tax revenue recycling schemes are investigated for domestic carbon tax. The simulation results show that a domestic carbon tax is a more cost-effective option than paying BCA. Given an identical carbon price at S$10/t-CO2, GDP, total exports and household consumption would decline less and average abatement cost is much smaller in the carbon tax scenarios compared to the BCA scenario. In terms of absolute emissions reduction, a carbon tax that covers energy, manufacturing and land transport sectors would be preferred, making emissions around 2.7% lower than 2010 baseline level.

17. Zhijia Tan, Qiang Meng, Fan Wang and Hai-bo Kuang (2018), Strategic integration of the inland port and shipping service for the ocean carrier. ***Transportation Research Part E: Logistics and***

Published Technical Papers (with Abstracts)

Transportation Review, Volume 110, Pages 90-109.

Abstract:

This study analytically investigates the competition and alliance strategies between one ocean carrier (OC) and one inland shipping company (IC) in a vertical container shipping chain. The OC decides the freight rate of the deep-sea shipping service, while the IC determines the freight rate of the inland waterway service including the charges of both shipping and port services. We examine and compare the outcomes under three strategies: vertical separation, vertical–horizontal competition and alliance. The if-then entry threat and excess revenue-sharing contract mechanisms for the OC to exercise the vertical-horizontal competition and alliance strategies are proposed, respectively.

18. Yadong Wang, Qiang Meng and Zhijia Tan (2018), Short-term liner shipping bunker procurement with swap contracts. ***Maritime Policy & Management, Volume 45, Issue 2, Pages 211-238.***

Abstract:

The bunker price fluctuations in recent years have severely threatened the stability of liner shipping companies' operations. As an efficient countermeasure, the swap contract is widely adopted throughout the liner shipping industry to hedge the procurement risk resulting from the bunker price fluctuation. This paper looks at the short-term liner shipping bunker procurement problem with swap contracts (BPPSC), aiming to optimally plan the amount of bunker purchased from the spot market and the amount hedged by the swap contract for several months ahead. This BPPSC is first formulated as a bunker procurement cost mean-variance minimization (MVM) model, and is subsequently solved using a tangible two-step approach developed in this study. In the first step, the movements of the swap contract price and the spot market price of the bunker are described using a calibrated multivariate generalized autoregressive conditional heteroskedasticity (mGARCH) time series model. In the second step, the MVM model is approximated and solved by a price scenario tree constructed from the mGARCH time series model. A numerical example shows that the risk hedging strategy obtained can simultaneously control the bunker procurement cost as well as the procurement risk from price fluctuations. This article is a revised and expanded version of the abridged eight-page paper entitled 'Optimal hedging for liner bunker procurement' presented at '2015 International Conference on Logistics and Maritime Systems (LOGMS 2015)', Hong Kong, 27–29 August 2015.

19. Hua Wang, Yiru Zhang and Qiang Meng (2018), How will the opening of the Northern Sea Route influence the Suez Canal Route? An empirical analysis with discrete choice models. ***Transportation Research Part A: Policy and Practice, Volume 107, Pages 75-89.***

Abstract:

The Arctic ice has been observed to be decreasing both in terms of extent and thickness since the 1950s in all sea sons due to global warming. The retreat of the Arctic sea ice creates unprecedented opportunities to maritime ship ping industry and opens the door for exploring new navigable shipping routes across the Arctic Ocean. The North ern Sea Route is of particular interest as it has the most favorable ice conditions among all transarctic routes and the Russia government has been actively encouraging international use of the sea route. This paper aims to quanti tatively assess the impact of opening of the Northern Sea Route on the Suez Canal Route by means of discrete choice model. Industrial preferences and choices under different situations are gathered by a state preference sur vey. Logit models are then built based on choice data from the survey. Based on modeling results, scenario anal yses are conducted to predict company's choices under difference cases and thus some policy insights are put for ward.

20. Man Zhang, Qiang Meng, Liujiang Kang and Wenquan Li (2018), Tailored Wakeby-type distribution for random bus headway adherence ratio. ***Transportation Research Part C: Emerging Tech-***

Published Technical Papers (with Abstracts)

nologies, Volume 86, Pages 220-244.

Abstract:

This paper addresses an interesting and practical bus headway adherence issue for a given public bus route with a number of bus stops. It first defines the random headway adherence ratio (HAR) at a particular bus stop of a specific bus route as the ratio of difference between actual bus headway and scheduled headway with respect to the scheduled headway. This study proceeds to customize a four-step procedure to estimate a probability distribution that can describe the random HAR at each bus stop of the bus route by using the automatic vehicle location (AVL) data. Our real case studies with 44,025 HAR data show that the 19 existing probability distributions including Lognormal, Gamma, Beta and Wakeby are unable to well fit these HAR data. This study thus proposes a tailored Wakeby-type distribution with five parameters. After deriving two fundamental propositions for the tailored Wakeby-type distribution, a tangible L-moment based method to estimate those parameters involved the tailored Wakeby distribution is presented. The tailored Wakeby-type distributions can meet our expectation via our real case studies. Finally, applications of the tailored Wakeby-type distribution derived for the random HAR are conducted.

21. Yadong Wanga, Qiang Menga and Haibo Kuangb (2018), Intercontinental liner shipping service design. *Transportation Science.*

Abstract:

Intercontinental liner container shipping service connects trades between different continents in the global logistic system. This paper proposes a single intercontinental service design problem that aims to jointly determine the optimal serviced ports from a set of candidate ports, the port rotation, the ship sailing speed on each voyage between adjacent serviced ports and the number of containers transported for each type of shipping demand. A mixed integer linear programming model is formulated for the proposed problem based on mild assumptions to maximize the service profit, which is calculated as the freight revenue minus the total operating cost that includes port stay cost, container handling cost, bunker consumption cost and other ship operating cost. The formulated model is also able to produce a service route with a more general topological structure than the simple cycle or butterfly cycle routes considered in most current studies. In view of the unique features of the model, a tailored and exact branch-and-cut algorithm is developed based on Benders decomposition to expedite the model solution. Numerical experiments demonstrate the efficiency of the developed branch-and-cut algorithm and show the applicability of the proposed model for designing the intercontinental liner shipping services.

22. Wen Hua and Ghim Ping Ong (2017), Network survivability and recoverability in urban rail transit systems under disruption. *IET Intelligent Transport Systems, Volume 11, Issue 10, Pages 641-648.*

Abstract:

It is important for an urban rail transit system network to be resilient in the event of a disruption, and to be capable to recover in the shortest possible time. This study presents a holistic approach to analyse the survivability and recoverability of an urban rail–bus transit network during and after a disruption. A maximum survivability-minimum recovery time approach was formulated in this study to determine the number of affected passengers in the rail network during a disruption, the number of passengers who need to be transferred to alternate transport modes, and the recovery duration. A case study based on the Singapore urban mass rapid transit and bus networks is presented to demonstrate the applicability of the authors' proposed framework. It was found from their analyses that the pro posed framework could provide information on the state of rail network resilience given different disruption scenarios and estimate the recovery time after disruption occurrence.

Published Technical Papers (with Abstracts)

23. Liujiang Kang, Qiang Meng and Qiang Liu (2018), Fundamental diagram of ship traffic in the Singapore Strait. ***Ocean Engineering, Volume 147, Page 340-354.***

Abstract:

The Singapore Strait plays a vital role for the international freight transportation, including containers, bulk cargo and crude oil. In view of the importance of Singapore Strait, it is of practical significance to investigate the ship traffic's speed-density relationship called the fundamental diagram in the Strait, which can be used to estimate the theoretical strait capacity. Despite the availability of large empirical ship traffic data and the long history of traffic flow modeling, the analysis of ship traffic fundamental diagram for the Singapore Strait is still highly deficient. To fill in the gap, we first develop a research framework to address the big AIS (automatic identification system) data for the ship traffic fundamental diagram building. To ensure the correctness of AIS data, a tangible error elimination method is presented. Moreover, a novel weighted least square approach is applied to develop the ship traffic speed-density formulations accurately. Meanwhile, we also show the applicability of the weighted least square approach by a theoretical investigation into the difference between the weighted and non-weighted least square approaches. Finally, we study all the fifteen legs in the Singapore Strait and propose 75 fundamental diagrams based on four classic traffic flow models through mining more than 43 million pieces of AIS data. These fundamental diagrams also indicate the theoretical capacity of each leg in the Singapore Strait.

24. Kjetil Fagerholt, Kap-Hwan Kim, Chung-Yee Lee, Qiang Meng and Xiangtong Qi (2017), Editorial of special issue on ocean transportation logistics: making global supply chain effective. ***Flexible Services and Manufacturing Journal, Volume 29, Issue 3-4, Pages 309-311.***

Abstract:

Maritime logistics plays an important role in enabling global supply chain networks. The research of maritime logistics has expanded its scope, from terminal operations and vessel routing, to strategic-level problems such as competition and collaboration issues. This special issue of the Flexible Services and Manufacturing (FSM) Journal aims to address problems related to maritime logistics from various perspectives.

The idea of editing this special issue was initiated with the planning of The 5th International Conference on Logistics and Maritime Systems (LOGMS 2015). The conference, sponsored by the Theme-based Research Scheme of Hong Kong RGC (T32-620/11), was held in The Hong Kong University of Science and Technology, 27–29 August 2015. We promoted this special issue to the conference participants, and at the same time, we opened the submission to all researchers interested in maritime logistics. We received 30 submissions in total. After rigorous reviews, 11 papers were accepted. These papers cover a broad range of maritime logistics, which can be classified into three areas.

There are five papers studying container terminal operations, a conventional area with new issues to be addressed. Yu et al. (2017) study a quay crane scheduling problem which considers the tidal impact. Petering et al. (2017) study a problem of container storage location assignment at a transshipment Terminal. Two other papers consider the benefit of in-advance booking or making appointments, Gracia et al. (2017) aiming to reduce the terminal gate congestion, and Covic (2017) investigating how to facilitate the container re-marshalling operations. While the above consider problems for a single terminal, Heilig et al. (2017), study a problem of truck routing involving terminals and nearby inland facility sites.

Besides terminal operations, vessel routing is another important area of maritime logistics. There are two papers falling into this area. Thun et al. (2017) study liner network design problem with complex services structures, and Tirado and Hvattum (2017) investigate the problem of determining vessel departure time at a port in a given route.

Published Technical Papers (with Abstracts)

The last area is about problems beyond the conventional scope of maritime logistics. There are two papers addressing supply chain management involving ocean transportation, Andersen et al. (2017) focusing on the distribution of wood pallets, and Fan et al. (2017) proposing a general supply chain model. Revenue management, which has been well adopted in airlines, is less explored in the industry of maritime logistics. This special issue has one paper in this area, van Riessen et al. (2017), studying the pricing problem for different cargo classes. Finally, Yu et al. (2017) study the port-to-port competition in one region by game-theoretic analysis.

This special issue is the outcome from the joint hard work of the authors, reviewers, and the editorial team. We would like to thank all people involved in the process, as well as Hong Kong RGC Theme-based Research Scheme (T32-620/11) for the support to LOGMS 2015 and this special issue.

Conference Papers (with Abstracts)

1. **Ashref Aloui, Mounira Msahli, Talel Abdessalem, Stephane Bressan and Sihem Mesnager (2017), Preserving privacy in distributed system (PPDS) protocol: Security analysis.** ***In proceedings of IEEE 36th International-Performance Computing and Communications Conference (IPCCC), December 10th-12th, San Diego, California, USA.***

Abstract:

Within the diversity of existing Big Data and data processing solutions, meeting the requirements of privacy and security is becoming a real need. In this paper we tackle the security analysis of a new protocol of data processing in distributed system (PPDS). This protocol is composed of three phases: authentication, node head selection and data linking. This paper deals with its formal validation done using HLPSL language via AVISPA. We provide also its security analysis. Some performance analysis based on its proof of concept are also given in this paper.

2. **B. Hartono, S. R. Sulistyo, Kah Hin Chai, N. Indarti (2017), Effective knowledge management strategy and firm's size: Evidence from Indonesia construction firms.** ***In proceedings of 2017 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM): 681-685, 10-13 Dec 2017, Singapore.***

Abstract:

The objective of this study is to provide both theoretical propositions and empirical evaluations to the association between knowledge management strategy (KMS) and organizational performance within a project-based organization setting. Of particular interest, firm's size is included within the analysis as a possible moderating variable. Primary data is inquired by means of a cross-sectional survey within a specific context of Indonesia construction firms. Out of 262 invited firms, 106 provide usable data (40.5 % response rate). The result shows that empirical data partially supports the hypotheses. It is found that in general, a positive relationship is observable between implementation level of `codification' strategy and organizational performance. An unexpected, significantly negative association between `personalization' strategy and performance is also observable. Further evidence also shows that for larger construction firms, management of knowledge which focuses on the codification strategy yields superior performance. Inconclusive results for smaller size organization suggest that more follow-up studies are required.

3. **Chenhao Zhou, Loo Hay Lee, Ek Peng Chew and Haobin Li (2017), A modularized simulation for traffic network in container terminals via network of servers with dynamic rates.** ***In proceedings of Simulation Conference (WSC), 3-6 Dec 2017, Las Vegas.***

Abstract:

There are many design factors affecting the traffic efficiency in an automated container terminal. The traffic efficiency is also dynamically influenced by the nature of the job sequence in the specific container terminal, the number of vehicles deployed, and the respective yard planning strategies. Therefore, it is difficult to analyze such complexity using an analytical queuing model; however, challenges arise in a simulation study such as how to effectively model the impact of the critical design factors as well as the decision rules. In this study, we model the traffic system as a network of servers that represents both paths and junctions, for which the service rates are dynamically adjusted according to the respective states and decision rules. The model is implemented with O2DES.Net, an open-structured and modularized modeling framework. Numerical experiments illustrate the effectiveness of the developed models, with an application of the AGV network for an automated container terminal.

Conference Papers (with Abstracts)

4. **Xiao Jin, Haobin Li, Loo Hay Lee and Ek Peng Chew (2017), Optimal computing budget allocation via sampling based unbiased approximation.** ***In proceedings of Simulation Conference (WSC), 3-6 Dec 2017, Las Vegas.***

Abstract:

In a Ranking and Selection problem, the objective of allocation is vital in deriving the rule. However, most of these objectives do not have a closed form. Due to the high cost of a direct approximation, several cheap but biased substitutes were applied to simplify the problem. These simplifications however could potentially affect the optimality of efficiency and therefore influence its finite performance. Fortunately, due to the increasing accessibility of parallel hardware (e.g. GPU), a direct approximation is becoming more tractable. Thus, we want to test the performance of an allocation rule based on an unbiased and direct approximation, expecting an acceleration on the performance. In this paper, we target on one of the famous objectives, the Probability of Correct Selection (PCS). Numerical experiments were done, showing a considerable improvement in finite performance of our algorithm comparing to a traditional one.

5. **Si Zhang, Loo Hay Lee, Ek Peng Chew and Chun-Hung Chen (2017), Efficient computing budget allocation for optimal subset selection with correlated sampling.** ***In proceedings of 2017 IEEE/ SICE International Symposium on System Integration (SII), 11-14 Dec 2017, Taiwan.***

Abstract:

This paper mainly studies the problem selecting the top-m ($m \geq 1$) alternatives under common random numbers. We model the optimal subset selection problem with correlated sampling based on the optimal computing budget allocation framework. Based on this model, we derive the optimal allocation rules for best design selection problem and the optimal subset selection problem respectively under some assumptions, which are good enough and easily implemented.

6. **Haobin Li, Chenhao Zhou, Byung Kwon Lee, Loo Hay Lee and Ek Peng Chew (2017), A hierarchical modeling paradigm for multi-fidelity simulation of mega container terminals.** ***In proceedings of 2017 IEEE/SICE International Symposium on System Integration (SII), 11-14 Dec 2017, Taiwan.***

Abstract:

When designing a mega container terminal, simulation plays a key role in evaluating proposed configurations and strategies in terms of the targeted key performance indicators (KPIs). While there are currently several popular commercial software providing well-designed libraries and powerful graphic user interfaces, there are three major challenges: 1) the provided libraries are designed as a black box; only limited parameters and functions can be tuned, whereas other specific requirements such as simulating new equipment designs requires further support from the software developers; 2) many libraries are designed for evaluation at the operational level, i.e., tracking individual container movement. The scalability is limited for modelling a mega container terminal as it gets computationally expensive quickly; and 3) the libraries of simplified server-queue models are computationally affordable, but at the expense of details which gives important insights. To tackle these challenges, we proposed a hierarchical modelling paradigm that is suitable for simulation modelling of mega container terminals at different fidelity levels based on the O2DES.Net framework. With an open and modular structure, every terminal component with various fidelity models can be "plugged-and-played". This allows analysts from different backgrounds to conduct various types of analysis to meet their aims.

Conference Papers (with Abstracts)

7. **Hui Xiao, Hu Chen and Loo Hay Lee (2017), Optimal computing budget allocation for ranking the top designs with stochastic constraints.** ***In proceedings of Simulation Conference (WSC), 3-6 Dec 2017, Las Vegas.***

Abstract:

Comparing with the well-studied unconstrained ranking and selecting problems in simulation, literatures on constrained ranking and selection problems are relatively fewer. In this paper, we consider the problem of ranking the top-m designs subjected to stochastic constraints, where the design performance of the main objective as well as the constraint measures can only be estimated from simulation. Using the optimal computing budget allocation framework, we derive an asymptotically optimal allocation rule. The effectiveness of the suggested rule is demonstrated via numerical experiments.

8. **Weizhi Liu, Siyang Gao and Loo Hay Lee (2017), A multi-objective perspective on robust ranking and selection.** ***In proceedings of Simulation Conference (WSC), 3-6 Dec 2017, Las Vegas.***

Abstract:

In this study, we consider the robust Ranking and Selection problems with input uncertainty. Instead of adopting the minimax analysis in the classical robust optimization, we propose a novel method to approach this problem from the perspective of multi-objective optimization and Pareto optimality. More specifically, the performances of each design under various scenarios are reformulated as multiple objectives, and in this case, robust Ranking and Selection becomes a multi-objective Ranking and Selection. In order to determine the number of simulation replications to various scenarios of each design, a bi-level convex optimization is formulated by maximizing the surrogate of the large deviation rate function of the probability of false selection. Numerical results show the efficiency of the proposed procedure (PR-OCBA) compared with other methods.

9. **Haobin Li, Xiuju Fu, Xiao Feng Yin, Giulia Pedrielli and Loo Hay Lee (2017), Optimal design of master-worker architecture for parallelized simulation optimization.** ***In proceedings of Simulation Conference (WSC), 3-6 Dec 2017, Las Vegas.***

Abstract:

This study formulates and solves the design problem for a master-worker architecture dedicated to the implementation of a parallelized simulation optimization algorithm. Such a formulation does not assume any specific characteristic of the optimization problem being solved, but the way the algorithm is parallelized. In particular, we refer to the master-worker paradigm, where the master makes sampling decisions while the workers receive solutions to evaluate. We identify two metrics to be optimized: the throughput of the workers in terms of the number of evaluations per time unit, and the lack of synchronization between the master and the workers. We identify several design parameters: number of workers (n), the buffer size for each worker and for the master and the sample size m, i.e., the number of solutions used by the master for sampling decisions at each iteration. Numerical experiments show optimal designs over randomly generated simulation optimization algorithm instances.

10. **Liye Zhang, Qiang Meng, Zhe Xiao and Xiuju Fu (2018), A Multi-Regime Vessel Trajectory Reconstruction Model for Ships in Port Waters Using AIS Data.** ***In proceedings of Transportation Research Board 97th Annual Meeting Transportation Research Board, Jan 11 2018, Washington DC, United States.***

Abstract:

AIS data plays an increasingly important role in collision avoidance, risk evaluation, and navigation behavior

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study. However, the raw AIS data contains noise that can result in wrong conclusions. The authors propose a multi-regime vessel trajectory reconstruction model which includes three steps, including (i) outliers removal, (ii) ship navigational state estimation and (iii) vessel trajectory fitting. This model can reconstruct the vessel trajectory in different navigation states, namely hoteling, maneuvering, and normal-speed sailing. The normal-speed navigation trajectory is estimated with a spline model, which can fit any types of the trajectory even with circles. Then, the proposed model is tested and compared with other three popular trajectory reconstruction models based on a large AIS dataset containing the movement of more than 500 ships in Singapore Port. The results show that the proposed model performs significantly better than the linear regression model, polynomial regression model, and weighted regression model. The proposed model can decrease the abnormal rate of speed, acceleration, jerk and ROT (Rate of Turn) from 43.42%, 10.65%, 59.25%, 50.33% to 0.00%, 0.00%, 17.28% and 15.81%, respectively. More importantly, the navigational behavior, such as turning operation which is extremely important in risk study, could be clearly shown in the trajectory reconstructed by the proposed model.

11. Zhaoyang Lu, Liujiang Kang and Qiang Meng (2018), Determination of Minimum Distance to Obstacle Avoidance in the Singapore Strait. ***In proceedings of Transportation Research Board 97th Annual Meeting Transportation Research Board, Jan 11 2018, Washington DC, United States.***

Abstract:

In the maritime simulation models of obstacle avoidance, the parameter of the critical contact closest point of approach (CCPA) is defined as the minimum safe distance to avoid an obstacle contact. Although the parameter of CCPA plays a decisive role on the avoidance safe route, it is generally set with an uncalibrated input value in most obstacle avoidance simulation models. This study is concerned with the parameter determination of the critical CCPA, by utilizing Automatic Identification System (AIS) data in the Singapore Strait and maneuver simulation experiments. Firstly, to identify ship obstacle avoidance from the big AIS data, an effective method is proposed. Then, together with several obstacles and the AIS data in Singapore Strait, the average critical CCPA values are identified for different ship classes. Secondly, to evaluate these critical CCPAs, a series of maneuver simulation navigational experiments in Dalian Maritime University were conducted by using their navigation simulators and professional captains. Consequently, the simulation-based critical CCPA values are derived. Finally, the average critical CCPA values deduced from the above two methods are compared. Their comparison results reveal that these CCPA values, derived from AIS data and maneuver simulators, are matched and confirmed each other's rationality. Furthermore, it is also found that the average critical CCPA value for each ship class has an increasing trend with the increase of ship length.

12. Zhaoyang Lu, Liujiang Kang and Qiang Meng (2018), Impact Analysis of Large Ships on Shipping Traffic Capacity of the Singapore Strait. ***In proceedings of Transportation Research Board 97th Annual Meeting Transportation Research Board, Jan 11 2018, Washington DC, United States.***

Abstract:

The Singapore Strait, as one of the busiest shipping waterways in the world, has several narrow segments that are considered as the chokepoints of the Straits of Malacca and Singapore. With the increasing emergence of large ships, the strait traffic capacity, which is a significant issue for the strait operation and management, will be undoubtedly affected. This study aims to assess the shipping traffic capacity of Singapore Strait under the impacts of various vessel compositions, especially including the large ships. To achieve it, an estimation method for the strait capacity and its variance is developed by utilizing the distribution of the minimum distance to collision among different vessel types. Next, based on the statistical analysis of AIS data collected from the Singapore Strait, the values of strait capacity and its variances were estimated in two chokepoints of this strait. The empirical results confirm that the estimated values of strait capacity are decreasing with the increasing proportion of the large ships.

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Moreover, the parameters of the strait width, vessel size, vessel compositions and travel speed are identified to have direct impacts on the assessment of strait capacity.

13. Zhaoyang Lu, Liujiang Kang and Qiang Meng (2018), Impact Analysis of Large Ships on Shipping Traffic Capacity of the Singapore Strait. ***In proceedings of Transportation Research Board 97th Annual Meeting Transportation Research Board, Jan 11 2018, Washington DC, United States.***

Abstract:

The Singapore Strait is one of the most important waterways in the world as it forms the main shipping route between the Indian Ocean and the Pacific Ocean. With the continuous growth in world trade, marine traffic flow has tremendously increased in Singapore Strait in the past decades. In addition, ship sizes have also steadily enlarged as the economies of scale achieved through the deployment of larger ships help to reduce operating costs. Ship's manoeuvrability and controllability behaviour are significantly affected by its size. It is believed that the traffic characteristics in Singapore Strait will be potentially varied with size and density distribution of ships arriving at the Strait, which maritime authorities will be very interested in for marine traffic management. In this paper, the authors investigate the spatial-temporal distribution of ship arrival at the boundary of Singapore Strait, where vessel headway is divided into four types: small ship-small ship, small ship-large ship, large ship-small ship, large ship-large ship. It is confirmed that ship headway is significantly different with ship size. The authors further statistically study the effect of different factors on ships' spatial-temporal distribution. The analysed results demonstrate its potential application in strait capacity estimation and maritime simulation studies.

14. Min Xu, Qiang Meng and Liujiang Kang (2018), Bus Operating Time Estimation at Bus Bays Considering the Impact of Bus Bunching and Second Door Opening. ***In proceedings of Transportation Research Board 97th Annual Meeting Transportation Research Board, Jan 11 2018, Washington DC, United States.***

Abstract:

Bus bunching and second bus door opening are two undesired phenomena that occur frequently at bus bays with multiple and one loading area respectively. They reduce the efficiency of bus operations by inducing extra delays. A reliable estimation of these delays is necessary to evaluate service performance and thus provide insights into how to offer a more efficient and robust public bus transit service. This study focuses on bus operating time estimation at bus bays with special attention on the extra delays caused by bus bunching and second bus door opening. The bus operating time consisting of bus dwell time and entrance-exit clearance time is first defined along with the elaboration of the aforementioned two phenomena. Two models are proposed for bus bays with multiple and one loading area, in which the number of bus stagnated at bus bay before the targeted bus arriving and the occurrence indicator for the second door opening are incorporated as independent variables, respectively. The bus dwell time and entrance-exit clearance time are estimated sequentially by regression approach. The case study of bus bays along Vivo City and West Coast Road in Singapore suggests that the operating time would increase by 8.59s when the number of bus queuing in the bus bay increases by one, and the average delay caused by second door opening is 4.47s. In addition, the comparison and analyses of estimation results demonstrate the reasonability and applicability of the proposed models. This study may serve as a useful guide for bus operators.

15. Qun Meng and Szu Hui Ng (2017), Enhancing pattern search for global optimization with an additive global and local Gaussian Process model. ***In proceedings of Simulation Conference (WSC), 3-6 Dec 2017, Las Vegas.***

Abstract:

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Optimization of complex real-time control systems often requires efficient response to any system changes over time. By combining pattern search optimization with a fast estimated Gaussian Process model, we are able to perform global optimization more efficiently for response surfaces with multiple local minimums or even dramatic changes over the design space. Our approach extends pattern search for global optimization problems by incorporating the global and local information provided by an additive global and local Gaussian Process model. We further develop a global search method to identify multiple promising local regions for parallel implementation of local pattern search. We demonstrate our methods on a standard test problem.

16. **Logan Mathesen, Giulia Pedrielli and Szu Hui Ng (2017), Trust region based stochastic optimization with adaptive restart: A family of global optimization algorithms.** ***In proceedings of Simulation Conference (WSC), 3-6 Dec 2017, Las Vegas.***

Abstract:

The field of simulation optimization has seen algorithms proposed for local optimization, drawing upon different locally convergent search methods. Similarly, there are numerous global optimization algorithms with differing strategies to achieve convergence. In this paper, we look specifically into meta-model based algorithms that stochastically drive global search through an optimal sampling criteria evaluated over a constructed meta-model of the predicted response considering the uncertainty of the response. We propose Trust Region Based Optimization with Adaptive Restart (TBOAR), a family of algorithms that dynamically restarts a trust region based search method via an optimal sampling criteria derived upon a meta-model based global search approach. Additionally, we propose a new sampling criteria to reconcile undesirable adaptive restart trajectories. This paper presents preliminary results showing the advantage of the proposed approach over the benchmark Efficient Global Optimization algorithm, focusing on a deterministic black box simulator with a d-dimensional input and a one-dimensional response.

17. **Songhao Wang and Szu Hui Ng (2017), A joint Gaussian process metamodel to improve quantile predictions.** ***In proceedings of Simulation Conference (WSC), 3-6 Dec 2017, Las Vegas.***

Abstract:

Developing metamodels for quantiles can be inaccurate when the input estimates of the quantiles used to fit the model are noisy. In this paper, a multiple response model is developed to jointly model the quantile with a correlated and less-noisy expectation to improve the fit and predictions from the quantile metamodel. We first extend the standard stochastic Gaussian process model to the multi-response case and then use a simple m-design-point example to analytically study the benefits of the joint model over the single model. Several other numerical experiments are also conducted, and the results show that the joint model can provide better performance and thus improve quantile predictions.

CMS Research Seminars

1. **Optimal route location and distance toll for a build-operate-transfer highway, by researcher Dr. Lu Zhaoyang (Track leader: Professor Meng Qiang)**

   Seminar Abstract:

   This study proposes an interesting research problem with practical significance about how to optimally determine the route location and distance-based toll of a build-operate-transfer (BOT) highway in an intercity highway network with multi-type vehicles. This problem is first formulated as a bi-level mixed integer programming model in which the upper-level problem aims to minimize the network social cost with profit constraints via the selection of route location and distance-based toll, and the lower-level problem is a user equilibrium problem with multi-type vehicles. To obtain a global ε-optimal solution of the formulated bi-level integer programming model, a local cutting-plane based algorithm is designed. Finally, two numerical examples are conducted to assess the applicability and efficiency of the developed model and algorithm.

2. **Market-Based Measures for Reducing CO2 Emissions in International Shipping, by researcher Ms. Lee Xin Ni (Track leader: Associate Professor Ng Szu Hui)**

   Seminar Abstract:

   Increasing CO2 emissions in international shipping sector has necessitated the consideration of a range of CO2 reduction measures such as Market-Based Measures (MBM), also known as Market-Based Instruments, alternative fuels, technical and operational measures. This seminar focuses on MBMs and their suitability for international shipping.

   The analysis begins with a systems perspective of how MBM may lead to CO2 reduction, followed by a definition of two fundamental types of MBMs – bunker levy, a form of tax on fuel, and emission trading system. Next, key criteria used to assess MBM are consolidated from various sources. Comparing the two MBMs based on these criteria leads to the view that bunker levy is easier to implement. In view of the cumulative effect of CO2 and the time and resources required for technology change, it is argued that international shipping should adopt bunker levy in the immediate term while searching for a suitable MBM in the long term.

   This research area forms part of a joint project between CMS and ESI.

3. **Multi-agent based ship traffic simulation system for the Singapore strait: Design and Implementation, by Researcher Mr. Gao Song (Track leader: Professor Meng Qiang)**

   Seminar Abstract:

   In order to analyze the impacts of large ships on the navigational accident risk in the Straits of Malacca and Singapore (SOMS), a multi-agent based ship traffic simulation framework is established. The modular architecture consists of a navigation circumstance modelling module, a vessel generation module, a rule-based ship traffic simulation kernel and the navigational accident risk assessment module, supplemented by visualization components and an import function for geographical data (based on QGIS). The simulation system built has laid a useful foundation for accident risk assessment of future marine traffic for SOMS.

4. **Dynamic Optimization of Vessel Speed under Uncertain Weather Conditions, by invited speaker Mr. Debabrota Basu (Track Leader: Associate Professor Bressan Stephane)**

   Seminar Abstract:

   The International Maritime Organization (IMO) identifies speed optimization as a key operational measure for

for achieving energy efficiency through reduced emissions. Ocean Liner services have fixed port rotations and schedules. While the speed can be optimized for emissions, the service level in terms of scheduled arrival and departure need to be carefully considered not to lose market share. This already challenging problem is further complicated when uncertain weather conditions along the service route are considered. In fact, few contributions can be found that address this issue.

We study the operational problem of dynamically determining a vessel's speed, departure time and arrival time at each port of call under uncertain weather conditions. We model the minimization of cost, namely bunkering costs and early and delayed departure and arrival penalties, using the calculus of variations. The proposed algorithm leverages upon a discretization technique based on the Weierstrass–Erdmann condition. The numerical tests show the efficiency and effectiveness of this algorithm over standard techniques like IVP.

We are now adopting reinforcement learning algorithms like Q-learning to solve this issue. The learning paradigm enables us to be oblivious to the weather prediction model and the full information scenario required for the previous algorithm. Rather, it learns the interaction of the weather with the vessel speed as-it-goes and provides a data-dependent approach to optimize the vessel speed under uncertain weather conditions.

5. Literature Review on Performance Measurement, by researcher Mr. Jens Paul Landkammer (Track Leader: Associate Professor Chai Kah Hin)

Seminar Abstract:

In order to measure the success of R&D, it becomes necessary to understand the fundamental methodologies of performance measurements systems. Hence, this literature review shall give a brief overview of performance measurement definitions, areas, and levels of application. Furthermore, the principles of Key Performance Indicators and performance measurement in R&D shall be described.

