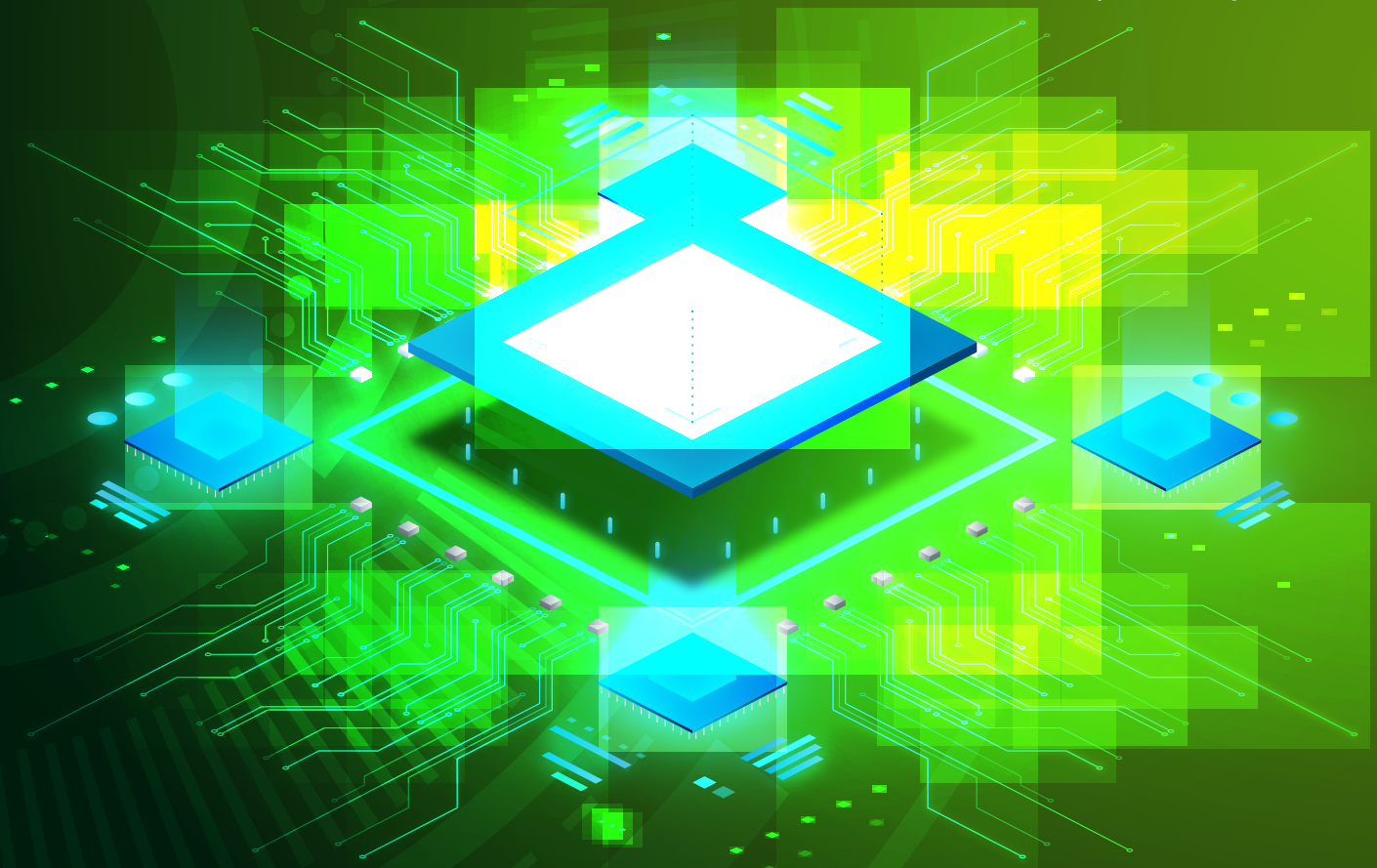
ISSN 2773-725X

CIS ComSpective

Enlightening perspectives on computing today and tomorrow

The ICT Magazine by the Department of Computing and Information Systems

- Technologies & Trends
- Research & Applications
- Professional & Personal Development
- Perspectives on Computing
- Software Development Projects



Volume: 02 Issue: 01 April, 2022

CIS ComSpective

Enlightening perspectives on computing today and tomorrow

With the aim of exploring today's world-changing sciences and technologies in the domain of computing, the Department of Computing and Information Systems at the Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka takes a step forward to unite with industry professionals and researchers through ComSpective the ICT Technical Magazine.

The magazine provides a brilliant opportunity for individuals who wish to contribute to the knowledge-base through submitting articles on technology insights, research investigations and experiences in the domain of computing.

Call for Articles
Volume 02 Issue 02

Important dates

Submission: 30th June 2022
Publication: 31st August 2022

We seek original submissions on the following topics of interest:

1. *Information Systems*
2. *Software Engineering*
3. *Pattern Analysis and Machine Intelligence*
4. *Security and Privacy*
5. *Signal Processing*
6. *Networking and Telecommunications*
7. *Human Informatics*
8. *Internet Computing*
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10. *Affective Computing*
11. *Knowledge and Data Engineering*
12. *Industrial Informatics*
13. *Robotics and Automation*
14. *Image processing and Computer Vision*
15. *Services Computing*
16. *Multimedia Technologies*
17. *Cloud Computing*
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The magazine also welcomes articles and contributions on various emerging and interdisciplinary topics

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Published by
Department of Computing and Information Systems
Faculty of Applied Sciences
Sabaragamuwa University of Sri Lanka
Belihuloya, 70140
Sri Lanka.

EDITOR'S NOTE

Dear Reader,

This beautiful country was once known for its educational, economic and healthcare advancements, which makes other developing countries in the region envied. However, the recent growing economic crisis and skyrocketing inflation rates have brought about many threatening issues to every Sri Lankan. As a result, people's lives are in crisis, and thus they are on the road forcing the government to stop the economic downturn so that people can get their lives back. Although there are a set of theoretical proposals available to overcome this substandard situation, experts in various fields are trying to explore innovative ideas to analyze the root causes and find solutions. As a responsible citizen of Sri Lanka, it is everyone's responsibility to hold up and help out fellow citizens in whatever way possible.

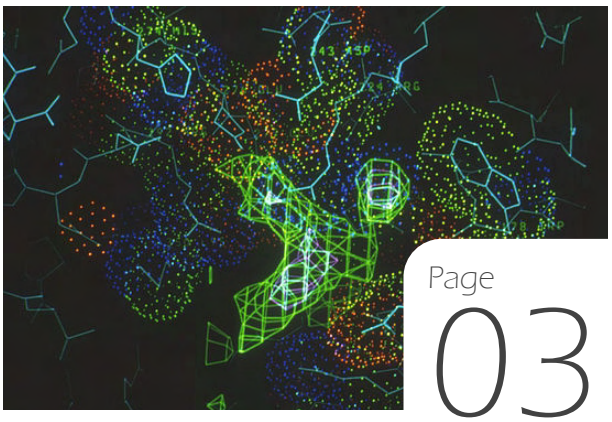
In terms of Information Technology (IT) market in Sri Lanka; it is primarily known for outsourcing both knowledge and process, IT services and software development. Sri Lanka's IT industry is capable of creating over 200,000 jobs and it would be expected to earn over USD 5 billion in the year 2023. Sri Lanka has been recognized within the first 50 countries as the most likable outsourcing destination by AT Kearney. Although the IT service sector has shown a steady growth in the past, tech start-ups have progressively gained attention in the last two years. While economists work towards finding the best possible solution for the current problem, as an IT personnel, our readers are also encouraged to be a part of the economic growth of the country.

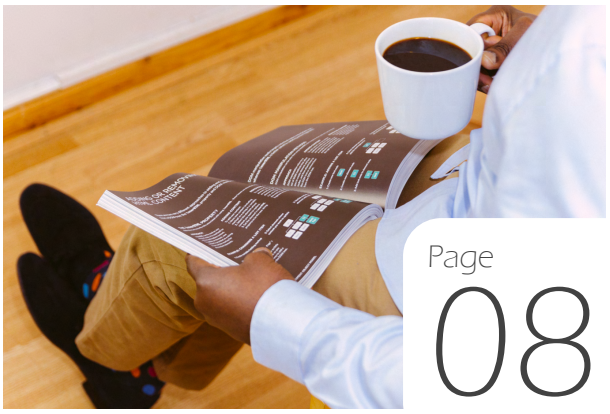
As a strong contribution towards a better future, the Department of Computing and Information Systems is marking its second successful year with the support of esteemed readers. We proudly present a new issue of the ComSpective magazine featuring a set of technology articles written by well-known technology experts across the country.

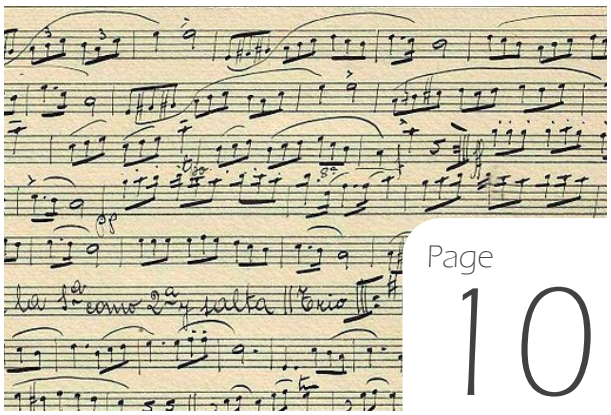
Thank you.

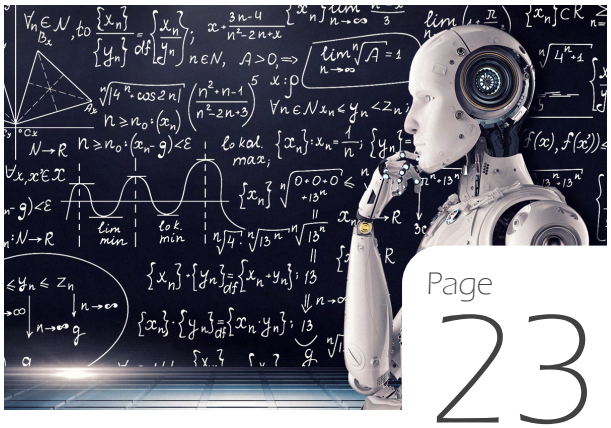
Selvarajah Thuseethan
Editor-in-Chief

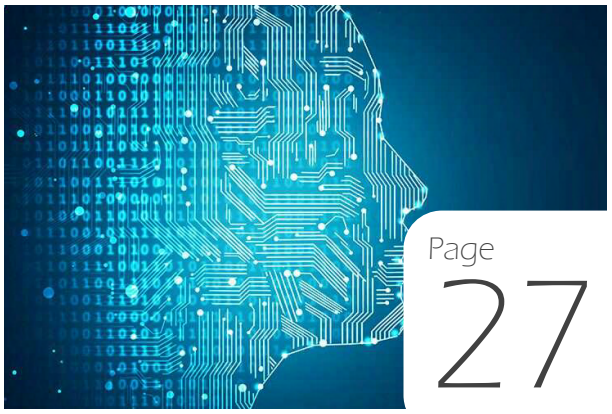
FEATURES







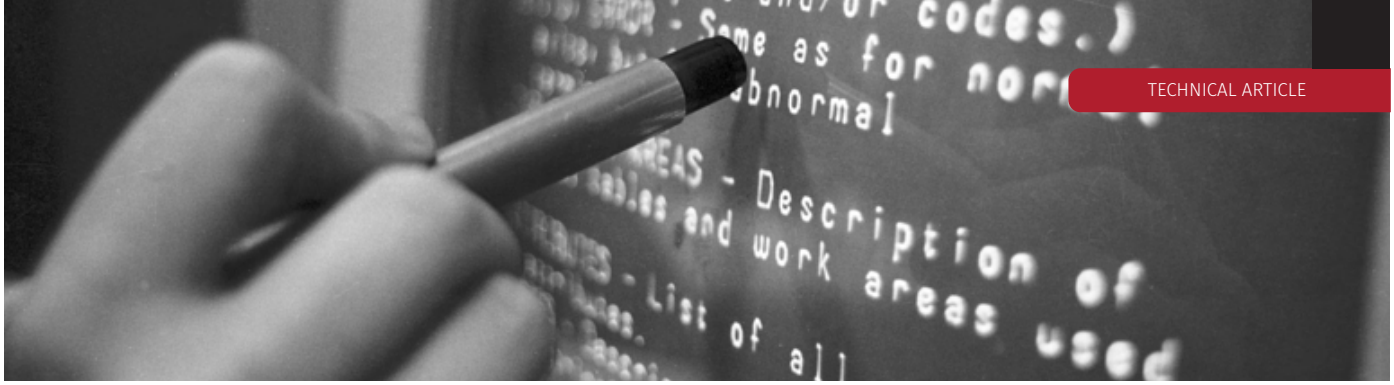




CONTENT

The Department of Computing and Information Systems is pleased to present the Second Issue of the First Volume of ComSpective, the bi-annual ICT magazine published by the Department of Computing and Information Systems.

We dedicate ourselves to making the world smarter, with each and every Issue of the Magazine, spanning a broad range of computing disciplines.



Short Text Topic Modeling: Models and Trends

Dr Wathsala Mohotti *(wathsala@dcs.ruh.ac.lk), University of Ruhuna*

The writer is a Senior Lecturer at the University of Ruhuna. She received the Ph.D. degree from QueenslandUniversity of Technology and her research interests are data mining, text clustering, outlier detection and cluster evolution.

Nowadays social media and other online platforms are heavily used by people in their social and commercial activities. Different social media platforms play an important role in facilitating the exchange of social views based on users' short-text communication. A massive number of short texts is generated every day on social media and web-based platforms in the forms of Tweets, news headlines, ad keywords, questions, answers, etc. Thus, retrieving information from short texts remains an important research task.

Topic modelling is one of the most powerful techniques in text mining for latent topic discovery through finding relationships among terms, topics and text documents. It links documents that share the same topic structure in a collection of documents by finding the structure of words that appeared in documents through probability distribution, distance or density-based similarity within matrix space. Figure 1 illustrates the task of topic modelling where topic proportionality and assignment is identified according to included word structure of documents.

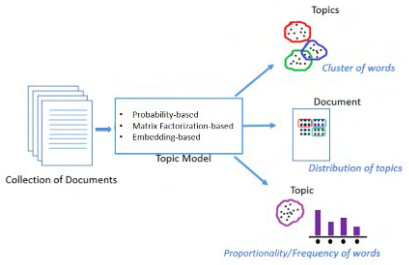


Figure 1: *Topic modelling process*

The origin of topic modelling runs back to year 2000 with the Latent Semantic Indexing (LSI) [1]. The basis for LSI-based topic model implementation converts high-dimensional, sparse word space to latent semantic space which reflects the topic space through Singular Value Decomposition (SVD)-based matrix factorization. Based on LSI, Probabilistic Latent Semantic Analysis (PLSA) [2] was proposed as a probabilistic topic model. However, Latent Dirichlet Allocation (LDA) which is proposed as a complete generative probabilistic model is the most popular in this field [3]. LDA models the contributions of different topics to a document by treating each topic as a probability distribution over words and thereby viewing a document as a probabilistic mixture of the associated topics. From that point, topic modelling research continued to boost and the LDA-based topic models exhibit outstanding performance in many studies.

After LSI, many methods are proposed under the matrix factorization paradigm which maps higher-dimensional document-word matrix into lower-dimensional topic space. Among them, Non-negative matrix factorization (NMF) [4] which is proposed in the late 90s, best suits text data due to natural non-negativity in text. Given a non-negative matrix V, NMF finds a low-rank approximation to V as a multiplication of two non-negative factor matrices W and H. i.e.: V ≈WH. This two factor matrices, W and H can be viewed as the document-topic matrix and the topic-term matrix respectively in topic modelling.

Another paradigm in topic modelling is embedding-based topic modelling and it addresses the lack of contextual information in (short) texts which resulted due to the fewer number of unique words in a document within the collection. Cur-

rently, several variations of text mining methods incorporated word embedding-based assistance to propose improved topic models.

Although there exists a myriad of topic modelling techniques that work well for traditional document collections, they are impaired in handling short texts. Specifically, a higher number of terms appear in the document-term matrix and associated sparseness lead to issues [5] in them to discover latent thematic structure in collections of texts. In short-text, where the length of the text vectors are relatively short and lead to extreme sparseness, standard dimensional reduction-based methods such as matrix factorization, probabilistic methods and traditional word embedding-based methods used in topic modelling show inaccurate outcome.

Recent research work in topic modelling for short text-domain includes document expansion-based topic modelling, deep neural word embedding-based topic modelling and matrix factorization with different assistance to overcome the limited length and lack of context in short text data. Additionally, short text topic modelling is challenged by the required additional pre-processing that go beyond standard stop word removal, stemming/lemmatizing and high/low document frequency filtering. The short text requires emoji removal, URL removal, username replacement, and punctuation removal due to the unstructured nature of the text. To cater to some of these requirements there exist designated packages designed for certain social media such as TweetNLP for the Twitter platform.

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Bioinformatics: An overview and its applications

Dr Pratheeba Jeyananthan *(pratheeba@eng.jfn.ac.lk), University of Jaffna*

The writer is a Senior Lecturer at the University of Jaffna. She received the Ph.D. degree from the University of Southampton and her research interestsinclude machine learning and bioinformatics.

Current advancements in technologies allow us to measure biological data in a vast range, which leads to molecular base studies in biology. Most of the biological questions are nowadays answered based on molecular level. These molecular data varies in many directions including, genome data, transcriptome data, methylation data, exon data, miRNA data, protein data, copy number data, mutation data and protein data. These data can be measured in three different levels, genome level, transcriptome level and translation level.

All of these data can be measured in different forms such as the sequence or quantity of the expression level, and available for biological researches. Structure or 3-D structure of few molecular data also vastly measured and used in the studies. Main types of molecular diagnostics include phenotype studies of the patients using these molecular data, biomarker identification, drug target prediction, sequence determination, protein structure prediction, functional annotation and differently expressed genes or bridging the gap between different molecular data, if possible.

Even though we are using emerging technologies for these measurements, the main challenge of these biological data is the bias in measurement. This is the big challenge while handling these data and biological replicates during the experiment are used to overcome this issue along with some significant measures such as the p-value, q-value and false discovery rate (FDR).

Apart from this challenge, the huge amount of information or data generated here, storing them and processing them is another challenge in this area. Bioinformatics or computational biology gives solution to this problem by providing different algorithms and methods. Further, advances in computing power and capacity assist us in the successful processing of these data.

Simply, bioinformatics is the combination of biology with computer tools to organize, understand, study, process and store the biological data. Main goals of bioinformatics are organize the data to be used by other researchers, develop algorithms and tools to analyse this data and use those developed tools in the data analysis to unravel the hidden biological truths.

There are dedicated databases to organize and store these bulk data in order to be used by the researchers. These curated data repositories can be differentiated in terms of the disease (different data for the same disease), functional databases or molecular data (particular data for different diseases). GenBank at the National Center for Biotechnology Information (NCBI), The Cancer Genome Atlas (TCGA), European Molecular Biology Laboratory (EMBL), Swiss-Prot/UniProtKB and PRIDE (PRotein IDEntification database) are few of such data repositories keep varieties of biological data free for any researchers.

Moreover, there are dedicated algorithms for analyzing these data. Dot-matrix methods, dynamic programming, consensus methods, genetic algorithms and hidden Markov model (HMM) can be used in the sequence analysis. Needleman-Wunsch, Smith- Waterman, FA-

STA and BLAST algorithms are few well-known specific algorithms used in Bioinformatics. This sequence analysis can be useful in comparing either multiple nucleotide sequences (DNA or RNA) or amino acids (peptides or proteins). It helps to study the evolutionary relationship between organisms or individuals, whole genome analysis or study the similarities and differences between multiple protein structures.

Another important aspect of bioinformatics is, molecular data used in biological studies. Measured expression level of different molecular data can be used in many studies which is collectively called as omic study. Each and every omic data can be measured using different technologies. For example, micro array, high throughput sequencing and single cell measurement are three famous techniques used in transcriptome measurements. Methylation 27K and 450K are two different methylation measures. These omic scale data can be used to find out the biomarker genes of a particular disease, drug target genes and especially a set of genes with the ability to predict the possibilities of a particular disease in a person.

Another important study in this line is finding out the differently expressed genes between two sets of people (may be healthy individuals and people with some particular disease) and study on those selected genes. This study is called as gene ontology (GO) analysis. This GO analysis reveals the functions and pathways related to given set of genes. These GO terms can explain the relationship between the selected genes and the disease. There are dedicated software for this analysis.

Another important direction in this area is bridging the gap between the molecular levels.

For example transcriptome data and proteome data. As per biological definition, the mRNAs (type of transcriptome) are translated into protein. Hence, one can hypothesize that there is a correlation between transcriptome and proteome. Also measuring the proteome data is comparably harder and expensive than measuring the transcriptome data. Hence, researchers tried to use the transcriptome data as the proxy to predict the proteome data. However, studies show that correlation between transcriptome and proteome is very low (nearly equal to 0.45). Therefore, researches are going on to bridging the gap between these two levels by including related factors (features influencing on translation) in a prediction model along with transcriptome data to predict the protein level.

There are much more interesting topics in bioinformatics. Currently, this field is very popular as it solves many important biological problems. As both biology and computer are two crucial fields of the current world, computational biology has a high impact on the current and future researches.

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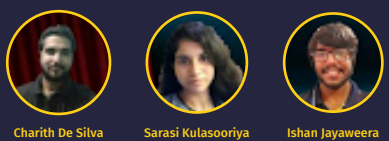
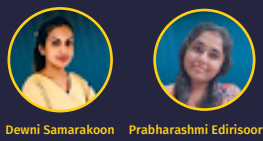
Congratulations!

Winners of hackX 2021

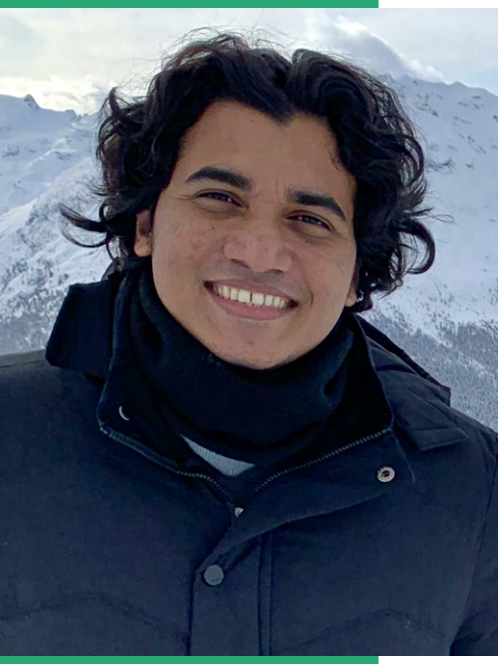


LES PIRATES SABRA



The team Les Pirates Sabra from the Department of Computing an Information Systems has won the 1st place at the HackX 2021 Organized by University of Kelaniya.

ALUMINI VIEWS



Contributing to the IT industry for over a decade

Mr Dilum Navanjana *(dilumnavanjana@gmail.com), received the BSc. degree from Sabaragamuwa University of Sri Lanka. He is currently a Lead Software Engineer at Shypple, Netherlands and his expertise includes web development using Ruby programming language, JavaScript, TypeScript and Elixir, Computer Vision, Deep Learning, Machine Learning, Pattern Recognition, Signal Processing, and Visual Object Classification.*

It was in 2011, I joined the Bachelor of Science in Computing and Information Systems degree program as the 4th batch of the department. One year later, we saw the first batch of the department entering the industry as fresh graduates. That was the initial assessment of the degree program quality which was welcomed by 100% employment rate.

There were multiple factors involved together to achieve the popularity the department has so far. Main factor is the up-to-date curriculum & revisions, the curriculum went through past years. This made the CIS graduates stand along shoulder to shoulder with other major universities.

Even though Sabaragamuwa university is not within a couple of hours reach from the capital, the internet narrows the distance. The labs & free internet facilities in the department make it even easier. Personally, those facilities helped me a lot to do self-studies over the 4 years.

Apart from the curriculum, there are many opportunities an undergraduate of CIS gets to showcase their skills. Personally, for me attending IT exhibitions representing the department helped to take a huge leap in my academics & career. The students of the department are attending all sorts of programming competitions locally and internationally and manage to take top ranks. Not only attending the competitions, but the department also organizes our very own hackathon & invites all universities.

For the first few years the department was a young competitor among several well-established ones. But every year it managed to widen the popularity through various career paths. There are CIS alumni members taking the department flag higher from Software Engineering to upper management in Sri Lanka & globally.

With the pandemic the IT industry is moving towards remote first globally. It proves the IT industry is very dynamic, the place you are located hardly makes any difference to your performances. Locating not close to the capital hardly makes any difference to the graduates of the department of Computing and Information Systems. As far as having a good academic staff to guide you & internet connection will level you with any university in the world. Programming while having a mountain range view is not something every university can offer.

How is the JavaScript code executed?

Mr Dilshan Fernando *(hdilshan.fernando11@gmail.com) and* ***Mr Banujan Kuhaneshwaran,*** *Sabaragamuwa University of Sri Lanka*

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Mr. K. Banujan is a Lecturer(Probationary) at the Sabaragamuwa University of Sri Lanka. He received the BSc. (Special) in Computing and Information System from Sabaragamuwa Universit of Sri Lanka and his Data Mining, Knowledge Management, Ontology Modeling, Business ProcessSimulation.

JavaScript (JS) is a computer language used largely by Web browsers to create a dynamic and interactive website. It gives a great user experience. Most of the functions and applications that make use of the internet in modern life are coded in some versions of JS. So, let's get an understanding of how a basic JS code executes inside the JS runtime environment.

In order to have a better understanding of how the JS code is executed, a small example code will be utilized as shown in Figure 1.

```
1  var n =  3;
2  function  multiplyByTwo(number){
3      var ans = 2 * number;
4      return ans;
5  }
6  var answerOne = multiplyByTwo(n);
7  var answerTwo = multiplyByTwo(2);
```

Figure 1: *Sample JS Code*

First, everything in JS executes inside the Global Executing Context (GEC). Let us see how this GEC is created with the help of JS code.

When the JS code executes inside the JS engine, it will create the GEC. This GEC has two main components, which are (i) memory and (ii) code. Moreover, this is created in two phases, which are known as (i) memory creation and (ii) code execution.

Let us see how the memory creation phase works.

In memory creation, GEC allocates memory for every function and variable. However, for the variable initial value will be undefined, not like variables, functions keep everything inside the function. Figure 4 illustrates the initial GEC.

Memory	code
n: undifined	
multiplyByTow : { ... entire code store in here }	
answerOne : undifined	
answerTwo : undifined	

Figure 2: *Initial GEC*

Then the code execution phase begins. Now JS again runs the whole code line by line. We will clearly see what happens line by line for the example shown in Figure 1. When JS executes the first line of the code, the "n" value will be replaced with the undefined "n" inside the memory. Then, with its function, at this moment, line two is not executed. So, it will move to line number six. Then the most amazing part happens, Function Invocation. When JS executes this line, the brand-new EC is created as shown in Figure 3.

Memory	code	
n: 3		
multiplyByTow : { ... entire code store in here }	**Memory**	**Code**
answerOne : undifined	**number:** undifined	
answerTwo : undifined	**ans:** undifined	

Figure 3: *Brand new EC*

Now, only code that exists inside the function will be executed.

So, JS allocates the memory for the number and answer variable and as before, the value will be undefined. The JS re-executes the code (which is inside the function).

Now, the "n" variable already has a value that equals 3. Then GEC updates the answer from undefined to 6. Updated EC looks like as shown in Figure 4.

Memory	code	
n: 3		
multiplyByTow : { ... entire code store in here }	**Memory**	**Code**
answerOne : undifined	**number:** 3	
answerTwo : undifined	**ans:** 6	

Figure 4: *Replace undefines*

Then JS reaches line number 4, which is the end of the multiplyByTwo function. When the function reaches the return keyword, JS returns and ends the function execution from that point. This return keyword states that return of the control of the program to the place where the function was invoked. After returning value 6, it will update the answerOne memory value.

Then the next amazing thing happens. The whole GEC, which is the instance of the function will be deleted. Now GEC looks like as shown in Figure 5.

Memory	code
n: 3	
multiplyByTow : { ... entire code store in here }	
answerOne : 6	
answerTwo : undifined	

Figure 5: *Instance of Function Deleted*

Then JS reaches line number 7. The same thing happens as happened in line number 6. The only difference between Line 6 and Line 7 is that there is no value assigned in Line 6 and there is a value assigned in Line 7. Once after executing line number 7, it looks like as shown in Figure 6.

Memory	code
n: 3	
multiplyByTow : { ... entire code store in here }	
answerOne : 6	
answerTwo : 4	

Figure 6: *Final stage in GEC*

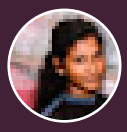
Now that you've learned a bit more about the execution process of JS code inside the environment of JS with this simple example of code.

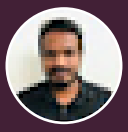
International Blockchain Olympiad (IBCOL-2021)

Merit Award

The Team ***Livestock Farm*** from the Department of Computing and Information Systems has won the Merit Award at the International Blockchain Olympiad.

On October 10th, 2021, the International Blockchain Olympiad Organizing Committee in collaboration with the Bangladesh Computer Council hosted IBCOL, the open-ended problem-solving culture of the hackathon with blockchain or distributed ledger technology, in which student groups from around the world participated. The "Blockchain-Based Livestock Farm application - SUSL" bagged the award for critically assessing a problem and coherently explaining the solution. The purpose of the application was to develop a holistic solution that integrates blockchain technology with smart monitoring technologies to make livestock farming in Sri Lanka more efficient, environmentally friendly, and economically viable.




Liskov Substitution Principle: Definition, Rules, Violations, and Implementation

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Introduction

Behavioural subtyping is an object-oriented programming principle that subclasses should satisfy the expectations of clients accessing subclass objects through references of superclass type, not just in terms of syntactic safety (such as the absence of "method-not-found" errors), but also in terms of behavioural correctness. Properties that clients may show using the specification of an object's supposed type, for example, should hold even if the object is a member of a subtype of that type.

The Liskov substitution principle (LSP) is a specific formulation strong behavioural subtyping, which was first described by the infamous American Computer scientist Barbara Liskov in a keynote lecture titled Data abstraction and hierarchy in 1988. It is built on the notion of "substitutability". Robert C Martin, famously known as “Uncle Bob” in the 2000 paper “Design Principles and Design Patterns” in which he formally introduced SOLID principles, added Liskov substitution principle (L of SOLID) as one of the software development principles aimed at making software designs more intelligible, adaptable, and maintainable.

Definition - Barbara Liskov introduced the principle as follows in the 1994 paper co-authored with Jeannette Wing:

Let ϕ(x) be a property provable about objects x of type T. Then ϕ(y) should be true for objects y of type S where S is a subtype of T.

Rules and Violations - Liskov substitution principle states that you should build your classes in such a way that client dependencies may be replaced with subclasses without the client being aware of the change. As a result, all subclasses must behave in the same way as their base classes. The subclass's functionality may change, but it must adhere to the intended behaviour of the original class. To be a real behavioural subtype, the subclass must not only implement the methods and attributes of the parent class, but also comply with its indicated behaviour. This necessitates adherence to a number of rules.

Rule of Contravariance and Covariance - This rule states that there should be contravariance between the base class's method parameters and the corresponding parameters in subclasses. This means that arguments in subclasses must be either the same kinds as those in the base class or less restrictive. Similarly, method return values in the base class and its subclasses must be covariant. This indicates that the return types of the subclass must be the same as, or more restricted than, the return types of the base class.

Rule of Conditions - This rule talks about pre and post conditions. A precondition is always meetings requirements before a method is called to ensure the call is successful. For example, in to call a method to find square root of a given number, which is passed to the method as an argument, the number must always be a positive integer.

Postconditions explain the status of objects following the completion of a procedure. For example, after performing a data streaming operation via network sockets, the socket must be closed. According to the LSP

, a base class's preconditions cannot be strengthened by a subclass, and postconditions cannot be weakened in subclasses.

Rule of Invariants - An invariant is a logical assertion of a process that is true before it starts and stays true after it finishes. A class, for example, may have a method that reads text from a file. For example, if a method reads data from network stream, the invariant may be that the content over the network is not open before or after the method call. The invariants of a base class must not be modified by a subclass in order to conform with the LSP.

History Rule - History constraint (or the history rule) prohibits the introduction of methods in subtypes which may allow state changes in the subtype that are not permissible in the supertype. For example, if base class is defined with a capability to read network chunks of a fixed size, the subclass, should not have a method which modifies the fixed size in the base class.

Rule of Exceptions - Liskov substitution principle also prohibits the exception throwals by the subclass unless if the same exception happens in the base class. An example of such exception is Square subtype from Rectangle super type (is-a relationship: Square is-a Rectangle) where getWidth() method throws exception or a not implemented exception since all four sides of the square are equal and the value can be retrieved through getLength() method. This is a violation of the Liskov substitution principle.

Decorator Pattern Implementation - GoF Decorator pattern is one way to implement a program not violating Liskov substitution principle. In this example we are going to implement a decorator pattern for Cars, implementing a base interface Vehicle. With this implementation we can decorate any substitutable type of Vehicle.

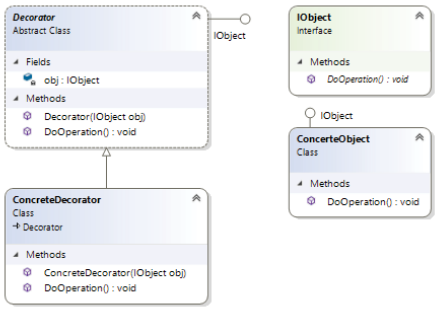


Figure 1: *Decorator pattern for Cars*

C# implementation of decorator pattern adhering to the Liskov substitution is available here: https://dotnetfiddle.net/rKMkKU

BEST PAPER AWARD

6th International Conference on Information Technology Research (ICITR 2021)

Paper Title

Novel Approach for Load Balancing in Mobile Cloud Computing

6th International Conference on Information Technology Research (ICITR 2021) Best Paper Award for the 'Internet of Things & Robotics Track' has been awarded to Isuru Ranapana , the paper titled "Novel Approach for Load Balancing in Mobile Cloud Computing"

Isuru Ranapana
Author

Dr K P N Jayasena
Supervisor

MUSIC and DATA

Ms Tharika Chalani Weerakoon, *University of Ruhuna*

The writer is a Probationary Lecturer in Computer Science at the University of Ruhuna.She received the BSc. degree from Sabaragamuwa University of Sri Lanka and her research interests are machine learning, image processing, and computer vision.

Music is claiming to be the essence of life. Anything having a rhythm is a source to music: Living things breathing, resonances of non-living things influence music. Music is an aesthetic component, yet scientifically proven. According to science, music is the systematic study of sound creation which analyze patterns pertaining to eliciting motion of sound waves. Music has evolved since the human evolution and is currently using more technologically advanced methodologies of composing, editing and rendering. Moreover, music has approached to numerous varieties which are termed as genres. Classical, Country, Electronic Dance Music (EDM), Hip-hop, Rock, Jazz, Metal, Pop, Rap, Rhythm and Blues, Techno are such genres, but yet there are many other genres too which can be categorized with respect to the region, country and the culture [1].

Musical genres, as explained by the Italian musician Franco Fabbri, are the conventional categories that determine the nature of a musical piece, whether it belongs to a shared culture, tradition or a set of conventions. Musical genres play a major role in the music industry. Every artist, build up his/her career within a genre and the music enthusiasts' preferences are based on genres. Also, musical awards and appreciations are based on genres. Hence, determining the correct genre that a music belongs to is a vital activity in music industry. According to experts, determining musical genres is highly subjective and biased. Different individual categorizes genres differently, creating a contrastive ambiguity.

As determining musical genre is crucial, yet challenging, it is worthy to research for automatic means of musical genre identification. As technology: musical composition tools, online music streaming applications is involved with music industry, musical data are abundantly existed and piled up at data repositories. The Music Information Retrieval (MIR) is the concept which can be adopted to scrape the music data from particular data repositories. Furthermore, the wave signature of music, is another fruitful source of data, hence wave format can be analyzed and extract data pertaining to a particular music[2]. The underlying genre identification criteria is built upon the waveform of music. Different features of music wave format: tempo, beats, chroma shift, spectral centroid, spectral bandwidth, roll off, zero crossing rate, Mel-frequency Cepstrum Coefficients (MFCCs) can be used to determine and identify the musical genre that a particular music belongs to.

With MIR, Data Mining and Machine Learning techniques can be adopted to automatically determine the genre of a music. Many researches have been carried out by numerous researches, concentrating on genre identification, but yet couldn't achieve 100% accuracy. The best accuracy yielded was 99% on 10 genres where Data Mining and Machine Learning model consists of a correlation analysis for feature engineering and XGBoost algorithm for classification model.

In today's world, music and data aren't two domains. Music and data go hand-in-hand as musical data can be used to genre identification and classification. Furthermore, identifying musical genre using mu-

sic data, opens up opportunities to automatically analyze music popularity, similar artist identification, similar music identification, digital music plagiarism, fan-based music segmentations, music performance tours and etc. Moreover, the research can be extrapolated and extended to many multidisciplinary aspects, such as identifying potential listener groups for direct marketing in music industry, making suggestions on artist collaborations on composing music, identifying human/primate psychological simulation with respect to music genres and many other possibilities.

References

[1] C. McKay and I. Fujinaga, "Musical genre classification: Is it worth pursuing and how can it be improved?," ISMIR 2006 - 7th International Conference on Music Information Retrieval, no. January 2006, pp. 101–106, 2006.

[2] C. Inskip, "Music information retrieval research," Innovations in Information Retrieval, pp. 69–84, 2018, doi: 10.29085/9781856049733.006.

2nd International Conference on Advanced Research in Computing ICARC 2022

*Composed by **Dr Sugeswari Lekamge** (slekamge@appsc.sab.ac.lk), and **Ms Subodhi Wasalthilake** (subodhi@appsc.sab.ac.lk), Sabaragamuwa University of Sri Lanka*

The 2nd International Conference on Advanced Research in Computing - ICARC 2022 organized by the Department of Computing and Information Systems, Faculty of Applied Sciences, Sabaragamuwa University of Sri Lanka was successfully held on 23rd and 24th February 2022. In an era of technology transformation where digital solutions play a critical role in the successful execution of activities in all spheres, the conference this year was held under the theme "Towards a Digitally Empowered Society". The Inauguration Ceremony was held at the Faculty of Geomatics Auditorium with the graceful presence of Professor R.M.U.S.K. Rathnayake, the Vice Chancellor of Sabaragamuwa University of Sri Lanka and the Guest of Honour Professor Pradeep Abeygunawadhana, the Chair of the IEEE Sri Lanka Section for the Year 2022. Various other distinguished guests including academics, industry professionals, and well-wishers were present at the ceremony. The Technical Sessions were held virtually at the Faculty of Applied Sciences due to the current health concerns.

The Department of Computing and Information Systems takes pride in remarking that ICARC 2022 was technically co-sponsored by the IEEE Sri Lanka Section, IEEE Computer Society of Sri Lanka, and the Sri Lankan Chapter of IEEE Communications Society, with the papers published in IEEE Xplore Digital Library. The conference was also recognized by the IEEE Women in Engineering (WIE) Sri Lanka Section. Since its debut in 2021, ICARC has attracted a lot of interest for the broad breadth and excellent quality of research papers it has received.

Sixty eight full papers received both locally and internationally were presented this year under nine tracks namely;

- Artificial Intelligence and Machine Learning (28)
- Data Science and Applications (05)
- Parallel and Distributed Computing (04)
- Software Engineering (03)
- Knowledge Management & Information Systems (04)
- Human-Computer Interaction & Computer Vision (06)
- Technology-enhanced Learning and Teaching (05)
- Industry Research and Development (06)
- Open Track (07)

This year's conference was a collective effort empowered by a group of distinguished academics and professionals who served in the Advisory Panel, the Organizing Committee, and the Technical Program Committee that were represented by members from around the world.

The conference brought together eminent keynote speakers, plenary speakers, and special guest speakers composed of intellectuals, professionals, and entrepreneurs all on one platform, allowing the attendees to discuss recent innovations, technologies, and trends in a variety of computing disciplines. A keynote address on AI-based Video Analytics was delivered by Assoc. Prof. (Dr) Supavadee Aramvit from the Department of Electrical Engineering, Chulalongkorn University, Thailand, who is the IEEE Asia Pacific (Region 10) Director-Elect 2021-2022. A keynote address was also delivered on Developing Countermeasures to Protect People from Phishing Attacks in the Organizational Context by Dr Nalin Asanka, Assistant Professor in Cyber Security and Privacy from School of Computer Science, University of Auckland, New Zealand. Furthermore, a special guest speech was delivered by Ms Kasturi Chellaraja Wilson, Director/CEO, Hemas Holdings PLC., inspiring the female undergraduates and attendees on how to take up leadership roles, through illuminating experiences and challenges in her career path.

ICARC 2022 also featured a number of pre-conference workshops and tutorials organized with the aim of enhancing knowledge and understanding of the participants, fostering collaborations, and especially to aspire for tomorrow's computing professionals. Computer vision, intelligent chatbots, and robot operating systems were all covered in the workshops. Legal aspects of IT, software defined networks for cloud architectures, and protein interaction network analysis were among the topics covered in the tutorials. Realizing the pledge of IEEE WIE to work towards gender-diversified panels at all IEEE meetings, conferences, and events, the WIE Affinity Group of SUSL organized a panel discussion on Social Entrepreneurship and Women Empowerment in parallel to ICARC 2022.

The conference this year along with the contribution of SUSL towards a digitally empowered society was a dynamic and productive experience for all the attendees and we hope that ICARC 2023 would be even better with your participation and collaboration.

TPC Members of the conference

Technical Program Chair

Prof S. Vasanthapriyan
Sabaragamuwa University of Sri Lanka

Artificial Intelligence and Machine Learning Track

Dr Lochandaka Ranatunga
University of Moratuwa (Chair)

Prof B.T.G.S. Kumara
Sabaragamuwa University of Sri Lanka
(Co-Chair)

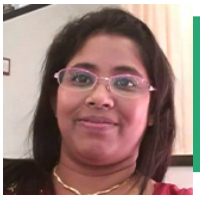
Data Science and Applications Track

Dr Chathura Rajapaksha
University of Kelaniya (Chair)

Prof R.M.K.T. Rathnayake
Sabaragamuwa University of Sri Lanka
(Co-Chair)

Parallel and Distributed Computing Track

Dr Windhya Rankothge
Sri Lanka Institute of Information
Technology (Chair)



Dr K.P.N. Jayasena
Sabaragamuwa University of Sri Lanka
(Co-Chair)

Human-Computer Interaction and Computer Vision Track

Dr Kasun Karunanayake
University of Colombo School
of Computing (Chair)

Mr R.L. Dangalla
Sabaragamuwa University of Sri Lanka
(Co-Chair)

Knowledge Management and Information Systems Track

Prof Lasith Gunawardene
University of Sri Jayewardenepura
(Chair)

Dr Thilini Bhagya
Massey University, New Zealand
(Co-Chair)

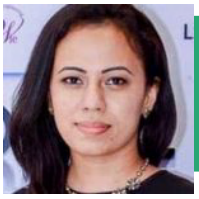
TPC Members of the conference

Software Engineering Track

Dr Jayalath Ekanayaka
Uva Wellassa University of Sri Lanka
(Chair)

Dr Hiruni Rupasinghe
Sabaragamuwa University of Sri Lanka
(Co-Chair)

Industry R&D Track



Ms Heshani Mahalaksha
Electrical Engineer at Ceylon
Electricity Board (Chair)

Ms Subodhi Wasalthilake
Sabaragamuwa University of Sri Lanka
(Co-Chair)

Technology-enhanced learning and teaching Track

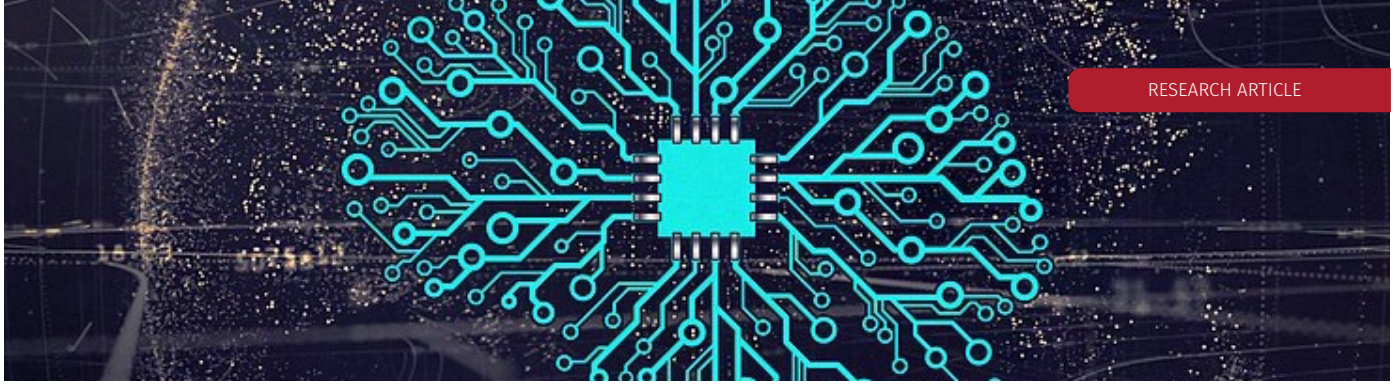
Prof Pradeep Abeygunawardhane
Sri Lanka Institute of Information
Technology (Chair)

Prof Prasad Jayaweera
University of Sri Jayewardenepura
(Co-Chair)

General/Open Track

Dr L.P. Kalansooriya
General Sir John Kotelawala Defence
University (Chair)

Dr L.S. Lekamge
Sabaragamuwa University of Sri Lanka
(Co-Chair)



Bird Species classifier using Convolutional Neural Networks.

Ms Binuri Raigamkorale *(yeshaniraigamkorale@gmail.com), University of Kelaniya*

The writer is a Probationary Lecturer at the University of Ruhuna. received the B.Sc. degree from the University of Kelaniya and her research interests include Data Science and Analytics.

Due to climate changes, many species of birds migrated to different regions. To protect them, we must first identify the species to which they belong and the special care that should be taken for their survival. According to the literature, Convolutional Neural Network (CNN) has made a massive contribution to image classifications.

Identifying the species of a bird from an image is a challenging task as it requires techniques such as image processing, CNN knowledge, domain expertise and needs high computational resources. Bird species identification can be challenging for humans as well, let alone computer vision algorithms.

The bird classification addresses the following challengeable key areas: various poses of birds (like flying, sitting with different orientations), background variations (water, sky, sands, etc.), colour intensity variations because they are taken at different times of the day like morning, evening etc.), class imbalances between species and difference between male and female birds' appearance. Males typical are far more diversely coloured while the females of a species are typically bland. Consequently, male and female images may look entirely different. To address mentioned deficiencies in bird's classifications, CNN is well trained to detect the features of objects, hence CNNs are very powerful for the analysis of images and work well for high dimensions.

The whole research work has been done using CNN (native architecture as considering baseline model) and pre-trained CNN models (Transfer Learning) namely RESTNet-50, MobileNet and VGG16. All the models are trained by 54000 images and tested and validated by 4000 images and size of 224x224x3. Among all the discussed models, the MobileNet model exhibits the best performance in terms of various indicators such as F1 score, precision, recall, and accuracy (94%). The training times of all networks used in the training and testing phase were tracked, and the duration of all networks was calculated for 50 epochs to make an accurate comparison in terms of time consumption.

All training and testing stages' time costs were calculated on a system using the GPU enabled computing system (NVidia GTX 1080 – 4 GB RAM), 16 GB RAM, I7 processors, and the Tensor Flow-based and Keras library. I present my best from scratch convolution model, the VGG16 model after a few iterations and MobileNet (which performed much better) and the SGD optimizer did better than ADAM. Further, we can use the transfer learning-based approach by removing the final layer classifier and using the extracted feature outputs as input into a new classifier (custom layered CNN classifier) to learn micro-level features, reduce training time, and enhance precision.

Keywords: *Birds Species Classification, Deep Learning, Convolutional Neural Networks (CNN).*

The Society of computer Science (SOCS)

The Society of Computer Science (SOCS) is an active society under the Department of Computing and Information Systems that is continuously devoted to uplifting the awareness of Information Technology of almost every student at Sabaragamuwa University of Sri Lanka. As well, there are other objectives which have been met by the SOCS in recent years, including fulfilling human and technical requirements of Information Technology in the University and organizing Information Technological events in the University.

Fortnight Meetup

Fortnight Meetup is an event organized by the Department of Computing and Information Systems of the Sabaragamuwa University of Sri Lanka in collaboration with the SOCS and IEEE. The meetings would be conducted once a fortnight by the Department of Computing & Information Systems with the utmost objective of enhancing the bond among the Undergraduates of the Department. The event focuses on uplifting the technological awareness among the Undergraduates, developing the soft skills and strengthening the relationship between one another. Following are a few editions of the programme held on past occasions.

FORTNIGHT MEETUP - 22nd Edition

The 22nd Fortnight Meetup was successfully hosted on the 30 th of April 2021. It was basically based on two presentations on the subject areas of “The Beauty of Blockchains” and “An Initial Exploration to Devops”, presented respectively by the speakers Harshana Saparamadu and Abisheth Varman, Undergraduates of the Department of Computing and Information Systems. The session was hosted by Thilini Anuradha.Winners of MadHack2021 Runners Up - Team OriginsWinners of MadHack2021 Runners Up - Team Origins

Speaker

Harshana Saparamadu
The Beauty of Blockchains
(3rd Year)

Speaker

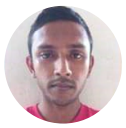
Abiseth Varman
An Initial Exploration to Devops
(2nd Year)

Hosted by

Thilini Anuradha
(2nd Year)

FORTNIGHT MEETUP - 23rd Edition

The 23rd Edition of the Fortnight Meetup was held on the 4 th of June 2021. The speakers were Ashen Iranga and Fathima Azha. The session was conducted by the speakers and the session was hosted by Pramith Wijethunga. The presentations were based on the topics “What is AI, ML, DL? conducted by Ashen Iranga and “Learn LEAN Methodology and Get in Demand” conducted by Fathima Azha.



Speaker

Ashen Iranga
What is AI, ML, DL?
(2nd Year)

Speaker

Fathima Asha
Learn Lean Methodology & Get in Diamond
(3rd Year)

Hosted by

Pramith Wijethunga
(3rd Year)

FORTNIGHT MEETUP - 24th Edition

The 24th Edition of the Fortnight Meetup was hosted successfu ly on the 20 th of August 2021. The resource persons were Yohan Malshika, a fourth-year Undergraduate and Adeeba Saleem, a third-year Undergraduate. The session covered “Flutter 101” co ducted by Yohan Malshika and “Agile Experiences on Industrial Training” conducted by Adeeba Saleem.

Speaker

Yohan Malshika
Flutter 101
(4th Year)

Speaker

Adeeba Saleem
Agile Experience in Innduarial Training
(3rd Year)

Hosted by

Hiruni Senevirathna
(2nd Year)

FORTNIGHT MEETUP - 25th Edition

The 25th Fortnight Meetup held on the 24th of September 2021 was also hosted on the online platform. The focus of this session was on the “5G and 6G Communication” and “Beauty of Neural Network” which were informatively presented respectively by Dewni Samarakoon, a first-year undergraduate and Nilupul Manodya, a 2 nd year undergraduate at the Sabaragamuwa University of Sri Lanka.

Speaker

Dewni Samarakoon
5G/6G Communication
(1st Year)

Speaker

Nilupul Manodhya
Beauty of Neural Network
(2nd Year)

Hosted by

Kamalka Chalanika
(3rd Year)

FORTNIGHT MEETUP - 26th Edition

The 26th Fortnight Meetup organized by the Department of Computing and Information Systems was successfully ended on the 15 th of October 2021 and it was also held online through Zoom. The speakers of the session were Sachithra Dilshan and Mayantha Fernando covering the topic areas “World of Microservices” and “Unveiling Kubernetes” respectively.

Speaker

Sachitra Dilshan
World of Microservices
(4th Year)

Speaker

Mayantha Fernando
Unveiling Kubernetes
(4th Year)

Hosted by

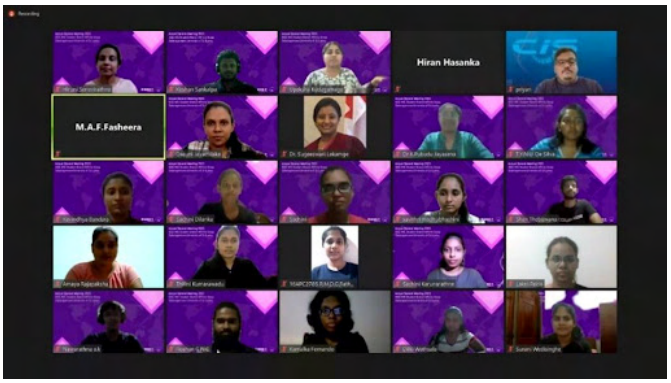
Amanda Kandambi
(4th Year)

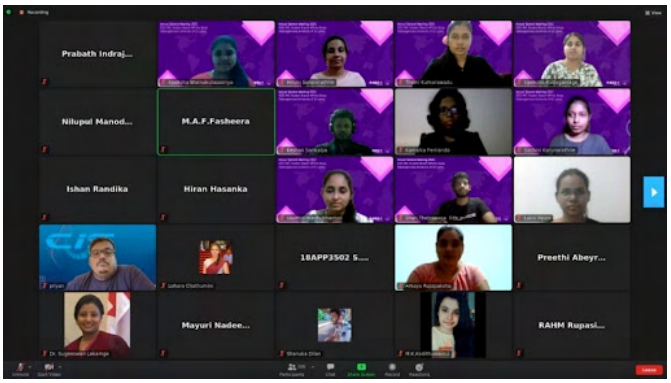
Women in Engineering Events

Sabaragamuwa University of Sri Lanka

Annual General Meeting

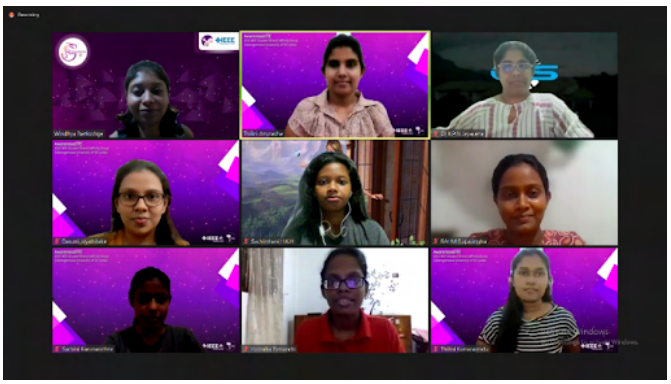
The first annual general meeting was held on the 23rd of June 2021 at 6 PM to 7 PM as an online event with the participation of Prof. Udaya Rathnayake (Vice-Chancellor of Sabaragamuwa University of Sri Lanka), Dr. Rasara Samarasinghe (The chairperson of IEEE WIE Sri Lankan Section), Prof. S. Vasathapriyan (Head, Department of Computing and Information Systems), staff of the Department of Computing and Information Systems and and the students. The objective of the meeting was to appoint executive members and committee members for 2021/2022 and to discuss about the future works of the WIE affinity group of SUSL.





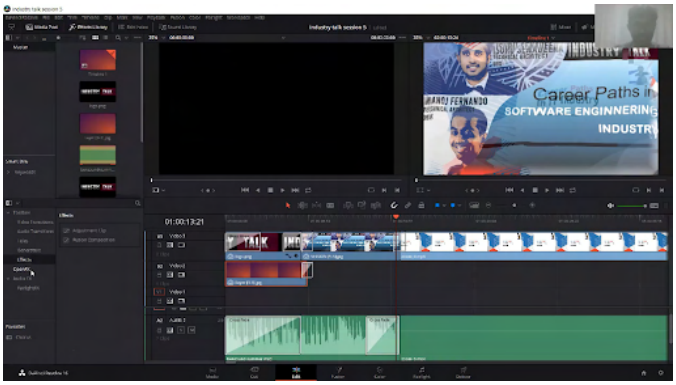
AwarenessEve

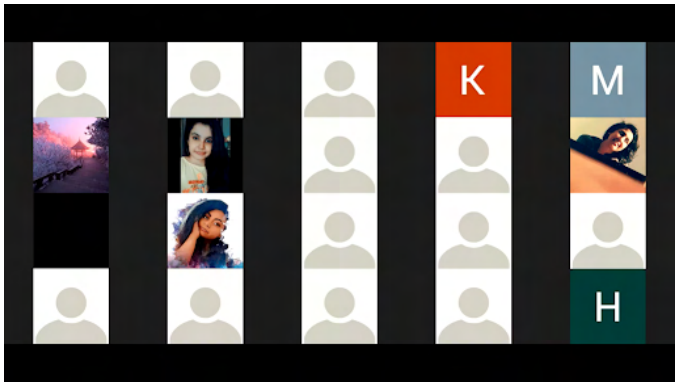
An Awareness session “AwarenessEVE” was held on the 1st of August 2021 at 6 PM to 7.30 PM with the participation of Dr. Windhya Rankothge, Assistant professor at SLIIT, ExCo member & Former Section Chair at IEEE WIE Sri Lanka Section as the resource person. The objective of the session was to enhance awareness about the IEEE WIE experience and encourage participants to join with IEEE WIE by outlining the benefits of membership.



Skills Development Program – WORKSHOP 01

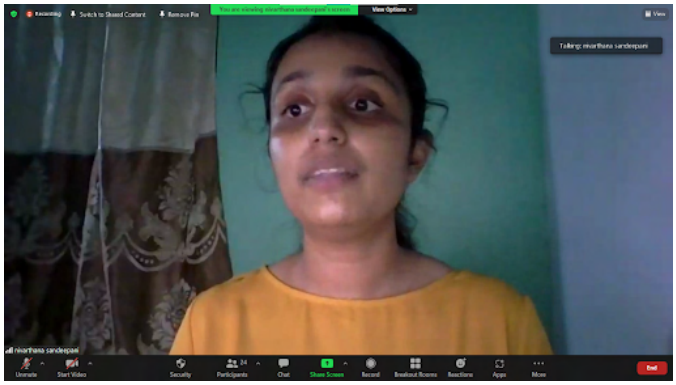
The first workshop of the skills development program; Editing & Designing workshop was held on the 2nd of September 2021 at 6 PM to 7.30 PM. The resource person for the session was Mr. Dilshan Maduranga, the Present Content Coordinator, IEEE student branch in the Sabaragamuwa University of Sri Lanka. The objective of the session was to sharpen the technical skills through workshops and make an opportunity to get experienced, especially female students who are interested in editing and designing.

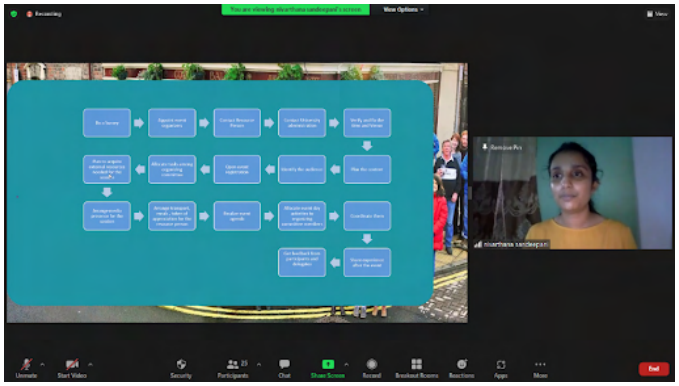




Skills Development Program – WORKSHOP 02

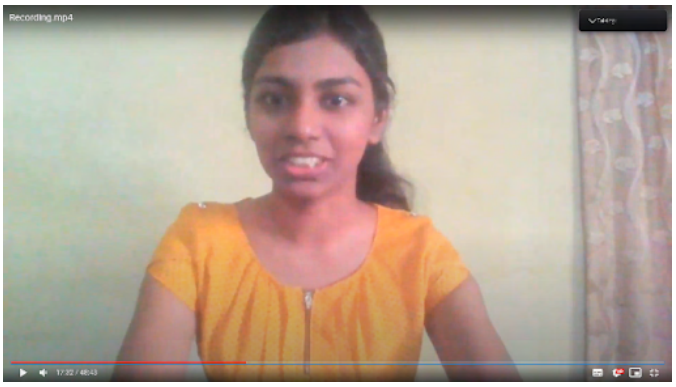
The first workshop of the skills development program; Editing & Designing workshop was held on the 2nd of September 2021 at 6 PM to 7.30 PM. The resource person for the session was Mr. Dilshan Maduranga, the Present Content Coordinator, IEEE student branch in the Sabaragamuwa University of Sri Lanka. The objective of the session was to sharpen the technical skills through workshops and make an opportunity to get experienced, especially female students who are interested in editing and designing.

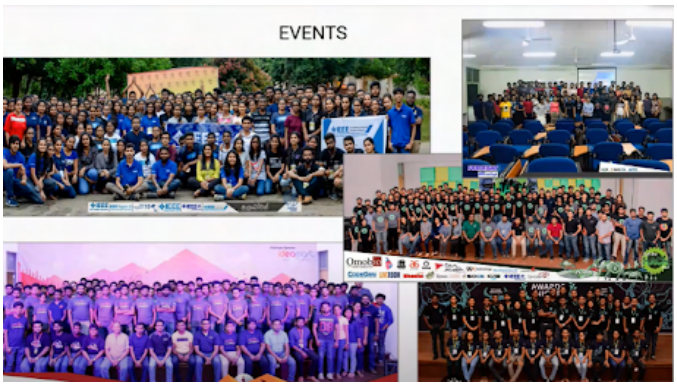




Awareness Program for Freshers

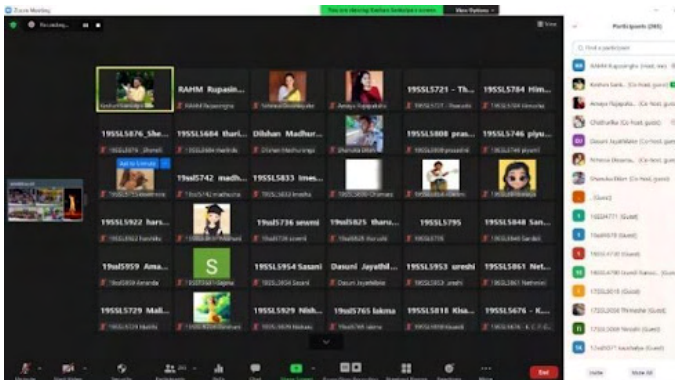
An awareness program for freshers of 2019/2020 batch was held on the 2nd of October 2021 at 10 AM to 11 AM with the participation of Mr. Hiran Hasanka - Chairperson of IEEE Student Branch of SUSL, Ms. Fathima Fasheera - Chairperson of IEEE WIE Student Branch Affinity Group and Mr. Dilshan Madhuranga - Content Coordinator of IEEE Student Branch in SUSL as resource persons. The session was mainly conducted to enhance awareness on what is IEEE, IEEE Student Branch of SUSL, IEEE Women in Engeening Student Branch Affinity Group of SUSL, past experiences and the journey with the IEEE and encourage participants to join with IEEE, WIE by outlining the benefits of membership.

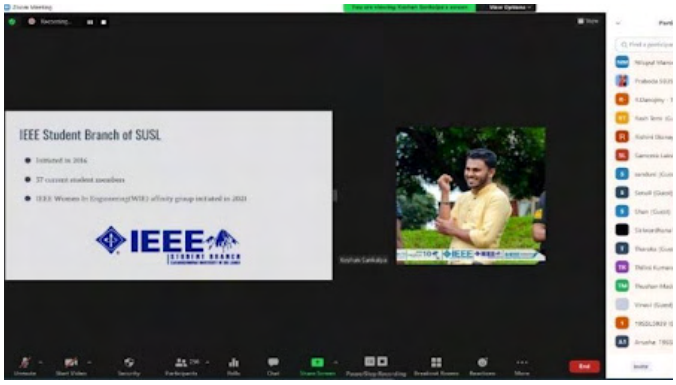




Awareness Program for Social Sciences Faculty

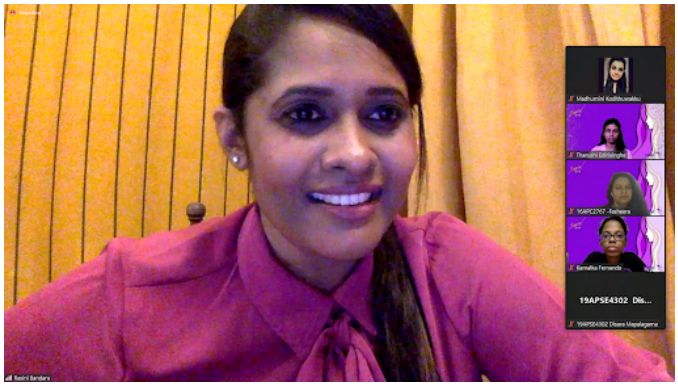
An Awareness Program for Faculty of Social Sciences and Languages was held on the 6th of November 2021 at 6 PM with the participation of Dr. R.A.H.M. Rupasingha - Head of the Department of Economics & Statistics, Faculty of Social Sciences & Languages, Mr. Keshan Sankalpa - Vice Chairperson of IEEE Student Branch of SUSL, Ms. Dasuni Jayathilake - Secretary of IEEE WIE Student Branch Affinity Group with the intention of raising knowledge about IEEE, SUSL's IEEE Student Branch, and SUSL's IEEE WIE Student Branch Affinity Group, as well as previous experiences and the IEEE's journey, and encouraging individuals to join IEEE, WIE by describing the benefits of membership.

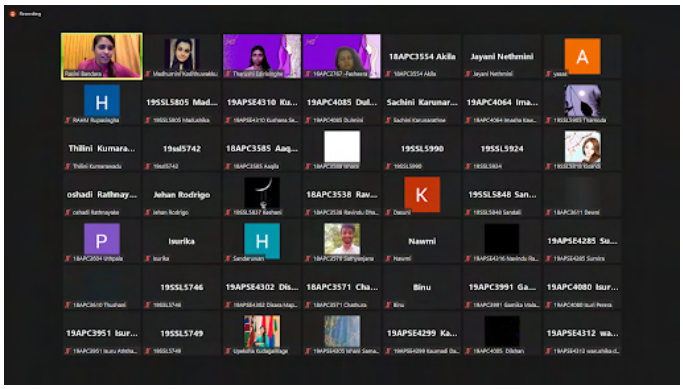




Sparc She - Stress Management Webinar

A stress management webinar; Sparc She was held on the 30th of November 2021 at 6 PM to 7.30 PM with the participation of Ms. Rasini Bandara, A psychologist, public speaker, personal development trainer, and psychology consultant. The objective of the session is to provide better guidance to balance life and work while dealing with academic or carrier stress.



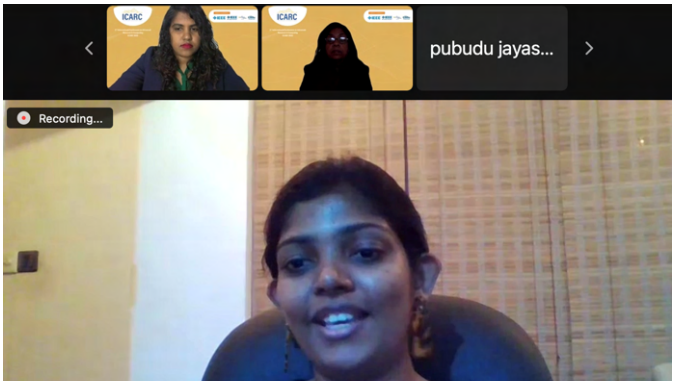


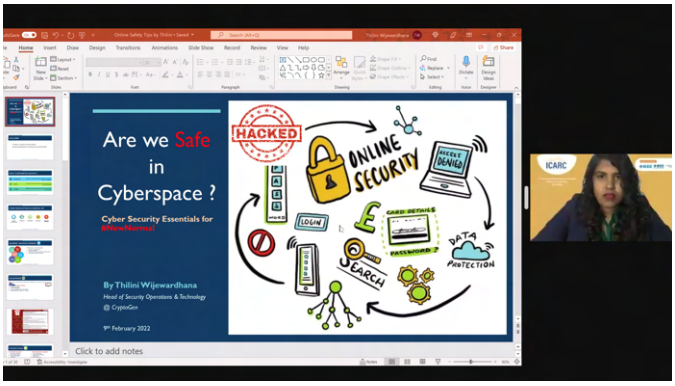
Sparc She - Cyber Safety Webinar

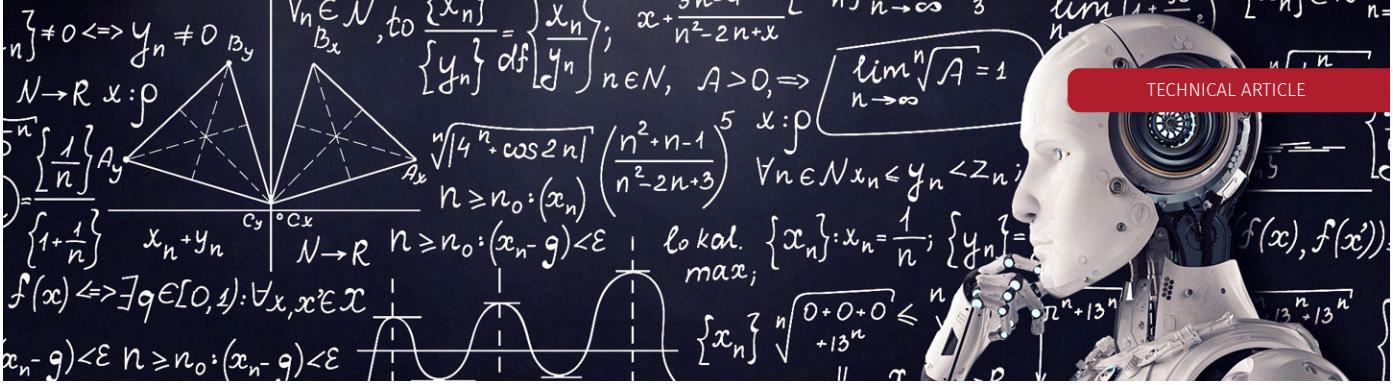
A cyber safety webinar, Sparc She was held on the 06th of January 2022 at 6 PM to 7.30 PM with the particiaption of Ms. Sureni Koshila, A IT Governance, Risk & Compliance Manager as the resource person with the intention of providing better guidance and awareness on how to deal with technology in their day-to-day life securely with recognizing and avoiding cyber threats.

Panel Discussion on Social Entrepreneurship and Women Empowerment

A panel discussion on “Social Entrepreneurship and Women Empowerment” parallel to the ICARC 2022 was held on the 09th of February 2022 at 6.30 PM to 8.30 PM with Prof. Kumudu Perera from Wayamba University of Sri Lanka, Mrs. Pulani Ranasinghe - Founder & Director, Loons Lab, Ms. Thilini Wijewardhana - Head of Security Operations & Technology, CryptoGen, Ms. Janani Liyanage - Scrum Alliance Agile Coaching Retreat Advisor. The objective of the session was to enhance the understanding of undergraduates on how social entrepreneurship can empower women leaders in various disciplines and to raise awareness on how to empower women by increasing their status through education, awareness, literacy, and training, as well as elaborating employment opportunities in various professions targeting University Students and Entrepreneurs.







Semi-Supervised Deep Learning Approaches for Classifying Surface Defects

Ms M. Mayuravaani *(mayu@univ.jfn.ac.lk), University of Jaffna*

The writer is a Lecturer at the University of Jaffna. She received the BSc. degree from the University of Jaffna and her research interests include Computer Vision, Deep Learning and Big Data Analysis.

Quality control is a process for maintaining standards in manufactured products by testing the output samples against the specifications. Surface defects have an adverse effect on quality and performance of industrial products. Surface defects sometimes affect the functions of a component and also spoil the appearance. The responsibility of industry is to reduce the complaints that arise from crashes, scratches etc. So that surface analysis plays an important role in the industrial world. During the surface inspection, the shells of the surfaces are commonly checked manually by the trained workers. Especially, companies that produce products in large numbers are hard to inspect one by one manually. It is obvious that manually classifying something is time consuming, high cost and also less accurate. To overcome this issue, vision based Automatic Surface Inspection (ASI) methods are proposed, as they are fast, highly accurate, and significantly reduce the labour intensity.

Figure 1: *Example image of defected surface*

In ASI, cameras are attached to the production line to capture the surface images. These recordings can be made by a number of cameras from different perspectives. Then captured images will be further analysed for the inspection using applications. Industrial applications will require well-structured data of possible defect types for the analysis. Various systems are proposed for different industrial applications, e.g., steel surface inspection, fabric/texture inspection, tile surface inspection, Aluminium profile surface inspection, and inspection of electronic commutators. However, developing a comprehensive and large data set for the classification is a challenging task as uneven light, strong reflection and also complex materials may appear on the surface.

There are publicly available benchmark datasets for researchers for this domain. In the Northeastern University (NEU) surface defect database [1], six kinds of typical surface defects of the hot-rolled steel strip are collected, i.e., rolled-in scale, patches, crazing, pitted surface, inclusion and scratches. Figure 2 shows some of the example images from each category of this dataset.

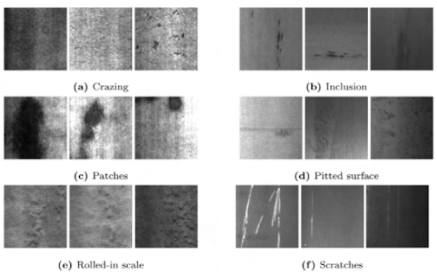


Figure 2: *Example images from NEU dataset*

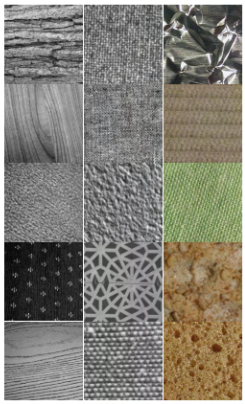


Figure 2: *Example images for surface texture dataset*

Another dataset is Texture dataset [2] which contains 64 classes from three public datasets. Figure 3 shows some of the example images from the surface texture dataset.

In recent years, deep learning in neural networks has achieved tremendous success in analysis of various domains. There are two main classification techniques in machine learning namely supervised learning and unsupervised learning. Supervised learning relies on labelled data, whereas unsupervised learning can handle unlabelled data for the classification. In supervised learning, the model learns from the labelled dataset and then is used to categorise new events. In an unsupervised scenario, the algorithm finds the similarity between different input data. The semi-supervised approach is something in between these two. The semi-supervised learning, using both labelled and unlabelled samples, provides another approach for training.

In the past, many studies have investigated the machine vision techniques for the surface defects classification. These methods mainly focused on traditional image processing and machine learning methods which are based on hand crafted features or shallow learning. Shallow learning techniques generally consist of two independent steps: feature extraction and classification. In the feature extraction step a set of hand-crafted features (e.g. Local Binary Patterns, Histogram of Oriented Gradients) are extracted to describe each image. These features are then used to learn a classifier (e.g. Nearest Neighbour, Support Vector Machines). These approaches have several limitations: As the features are not learned from the data they may not capture the domain-specific characteristics.

In recent years, researchers have begun to use deep learning in Convolutional Neural Network (CNN) which has achieved tremendous success in various domains as they can learn the feature extractor and the classifier together in an end-to-end learning setting. Since the features are learned from the given training data, they can be highly discriminative, and capture domain specific information. However, deep learning requires a large amount of data for training. To overcome this, transfer learning approaches are widely used, where a network trained using a large dataset (e.g. ImageNet) is fine-tuned for a specific domain. Recently, most of the proposed approaches are based on supervised learning. But the problem with supervised learning is it requires a large amount of labelled data. Labelling a large amount of data is time consuming and expensive as it requires expert knowledge to classify them.

Several state-of-the-art approaches have been proposed for this defect classification. Generative Adversarial Network (GAN) based approaches[5] have been used as they can generate new images and provide a way for augmenting the training set. Self-training[6] is another popular approach for semi-supervised learning. Pseudo labelling[3] is a simple and efficient method of semi-supervised learning for deep neural networks. Here, instead of manually labelling the unlabelled data, approximate labels will be given on the basis of the labelled data. Figure 4 depicts the steps involved in semi-supervised learning with Pseudo labelling.

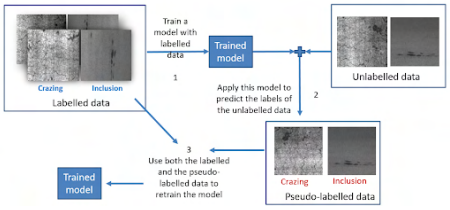


Figure 4: *Steps that involved in [seudo labelling technique*

The semi-supervised learning requires a small amount of labelled data for model training and unlabelled data can be used to improve the performance of the model. Here, the challenge is how to determine whether the predicted labels (pseudo-labels) are true labels or not. There are various weighting schemes [4] proposed to weigh the contribution of the unlabelled samples for the training. These schemes are based on the prediction probabilities and confidence in the prediction of a given unlabelled image. We determine the confidence of prediction of an unlabelled image based on how well an image is classified into one class compared to another class. So, the images with high confidence in prediction should get higher weights and the images with lower confidence in the prediction should get lower weights. In this way, a pseudo label image could be weighted and considered for the training to improve the performance.

There are several other directions that can be focused in this specific domain. Segmenting the defects improves classification accuracy and also contours of defects can

be extracted from the image.

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Code with WIE 2021

Achievement by members of the WIE affinity group of Sabaragamuwa University of Sri Lanka

2nd Runners Up

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Sabaragamuwa University of Sri Lanka

TEAM MEMBERS

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Madhumini Kodithuwakku

Chamodi Herath

Dewni Samarakoon

STAFF Publications

Indexed Journals

01. **Thuseethan, S.**, Rajasegarar, S. and Yearwood, J., 2022. EmoSeC: Emotion recognition from scene context. *Neurocomputing, 492,* pp.174-187.

02. **Thuseethan, S.**, Rajasegarar, S. and Yearwood, J., 2021. Deep Continual Learning for Emerging Emotion Recognition. *IEEE Transactions on Multimedia.*

Peer-reviewed Journals

01. Kithulwatta, W.M.C.J.T., **Jayasena, K.P.N.**, **Kumara, B.T.G.S.** and Rathnayaka, R.M.K.T., 2022. Integration With Docker Container Technologies for Distributed and Microservices Applications: A State-of-the-Art Review. International Journal of Systems and Service-Oriented Engineering (IJSSOE), 12(1), pp.1-22.

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02. Kithulwatta, W.M.C.J.T., **Jayasena, K.P.N.**, **Kumara, B.T.G.S.** and Rathnayaka, R.M.K.T., 2021, September. Docker incorporation is different from other computer system infrastructures: A review. In 2021 International Research Conference on Smart Computing and Systems Engineering (SCSE) (Vol. 4, pp. 230-236). IEEE.

03. Prasanth, S., **Banujan, K.** and **Kumara B.T.G.S,** 2021, September. Hyper Parameter Tuned Ensemble Approach for Gestational Diabetes Prediction. In *2021 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies (3ICT)* (pp. 18-23). IEEE.

04. **Kumara, B.T.G.S.**, Banujan, K., Prasanth, S. and **Herath, G.A.C.A.**, 2021, September. Constructing Global Researchers Network Using Google Scholar Profiles for Collaborator Recommendation Systems. In *2021 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies (3ICT)* (pp. 274-279). IEEE.

05. Gunarathne, K.A.A.B. and **Jayasena, K.P.N.**, 2021, December. Monitoring mental health disorder symptoms and behavioral problems of undergraduates in Sri Lanka using smartphone sensors. In 2021 International Conference on Decision Aid Sciences and Application (DASA) (pp. 544-549). IEEE.

06. **Palanisamy, V.** and Ratnarajah, N., 2021, December. Detection of Wildlife Animals using Deep Learning Approaches: A Systematic Review. In *2021 21st International Conference on Advances in ICT for Emerging Regions (ICter)* (pp. 153-158). IEEE.

07. **Thuseethan, S.**, **Wimalasooriya, C.** and **Vasanthapriyan, S.**, 2021, December. Deep COVID-19 Recognition Using Chest X-ray Images: A Comparative Analysis. In *2021 5th SLAAI International Conference on Artificial Intelligence (SLAAI-ICAI)* (pp. 1-5). IEEE.

Diabetic Retinopathy Fundus Image Grading Using Deep Learning: Research Directions

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The writer is a Lecturer in Computer Science at the University of Jaffna. Currently she is reading the Ph.D. degree in Computer Science at the University of Jaffna and her research interests include deep learning, medical imaging and computer vision.

Diabetic is a serious health issue caused by high blood sugar level. Nearly one third of diabetic patients suffer from Diabetic Retinopathy (DR) [1], which is an eye disease where the damage occurs in the retina (back side of the eye). Therefore, dark spots will appear in the vision from an affected eye. The vision from the normal eye and diabetic retinopathy are illustrated in Figure 1. DR is the leading cause of vision impairment or blindness. Researchers estimated that the number of people affected by DR worldwide will grow to 191.0 million by 2030 [2]. Even though the early stages of DR are typically asymptomatic, regular eye screening for diabetic individuals is necessary, as quick identification and subsequent care of the problems are critical. Because controlling hyperglycemia, hyperlipidaemia and hypertension is the only preventive therapy, early recognition of DR is even more important [4]. Furthermore, contemporary treatments, like laser photocoagulation can reduce the risk of blindness in proliferative retinopathy and diabetic maculopathy by up to 98%, if the eyes are treated early in the disease [5].

Figure 1: *A vision of a normal eye and of an eye diabetic retinopathy*

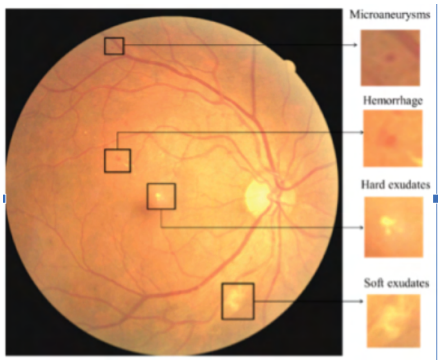


Figure 2: *Different types of DR lesions*

The affected DR contains different lesions (the affected regions of the retina) such as haemorrhage, soft exudates, hard exudates, and microaneurysms, which are illustrated in Figure 3 and this DR image is taken by a colour fundus camera. DR grading by distinguishing the lesions from fundus images is a challenging and fine-grained problem due to the lesions being smaller in size (covers only a few pixels in fundus images) and similar in visual appearance.

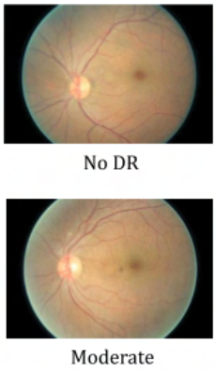


Figure 3: *Normal and Moderate DR images.*

For example, Figure 3 shows the normal and moderate DR images, where it's hard to differentiate them. Based on the type and amount of the lesions appears, the DR images will grade in a severity order which represent the progression of the disease like no DR (healthy), mild, moderate, sever and proliferative DR (complex stage). Here wrong identification of DR images may lead to sever consequences. Therefore, early and proper DR grading is important to decide the appropriate treatment at the correct time, as the treatment depends on the severity

or grade of the DR. Ophthalmologists usually rely on retinal colour fundus camera to examine the retina and detect the presence of lesions to grade the disease. This manual process is time consuming, subjective and prone to human errors. On the other hand, automated computer aided diagnoses systems show good potential to accurately grade the DR and provide objective predictions from colour fundus retinal images [7].

Recently, Deep Learning (DL), especially Convolutional Neural Network (CNN) based automated solutions were proposed, and achieved remarkable success for DR grading with effective prediction in a short time [7]. DL is a machine learning technique, which allows computational models to learn representations of data with multiple levels of abstraction and it has been widely used to solve problems in various domains including computer vision and medical imaging. CNN is a type of DL technique which is designed to automatically classify images and/or to detect regions of interest in images by learning spatial feature hierarchies through multiple levels of building blocks, such as convolution layers, pooling layers, and fully connected layers. Figure 5 illustrates a simple CNN architecture for DR grading. Various CNN based automated approaches have been proposed in DR image analysis including CNN architectures [6], pooling mechanisms [8], attention mechanisms [3], etc. Rather than that, there are various directions to the researchers to improve DR grading performance, including the followings:

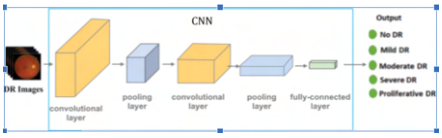
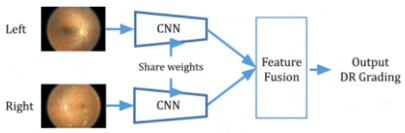


Figure 4: *Simple CNN architecture for DR grading*

Siamese network based feature fusion of both eyes of a patient - Automated DR grading is a fine-grained classification problem as the lesions in DR images are hard to distinguish due to scale, high intra- and low inter-class variations. Usually ophthalmologists determine the DR grading of an eye of a particular patient by examining both eyes of that patient as the DR grading of one eye may give guidance for the diagnosis of the other. Therefore, most of the approaches for DR grading [8] make use of the features from the left and the right eyes of a patient to determine the DR severity level of a particular eye of that patient, and show significantly improved DR grading performance by this information fusion. The kind of CNN architecture used for this purpose is called Siamese network [8]. Siamese networks are types of networks which have two or more identical CNNs each with different inputs, and the weights of these identical networks are shared among them. As the weights are shared, their parameters can be learned with less amount of data compared to training two independent networks. Figure 6 illustrates a sample architecture of Siamese network.



Semi-supervised learning for DR grading - Although CNNs are widely used for image classification and/or segmentation, they are often data-hungry – needs a large amount of annotated data to train as they have millions of parameters to train. However, collecting annotated data in large amounts, is usually a tedious task, particularly it is difficult for medical imaging. Recently semi-supervised learning approaches have been explored, where unannotated data was used in addition to the annotated data to boost the performance of the CNN system. Currently, more researches are focusing on this domain to improve DR grading performance with less amount of annotated data.

Joint classification and segmentation of DR lesions - Just classifying retinal images into one of the predefined classes will not give much valuable information to the ophthalmologists as they will not give any explanation or interpretation on why they are classified into a particular class than other classes. This interpretation may be obtained in terms of segmenting different lesions. Therefore, researchers can focus on a joint framework which will classify images as well as identify lesion regions to give justifications for ophthalmologists on why they are classified into a particular class than the other classes.

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NBQSA 2021

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&
Award for Most Innovative and Best Solution in Cloud Computing

PROJECT TITLE: A NOVEL HURISTIC BASED TASK SCHEDULING ALGORITHM IN CLOUD COMPUTING

STUDENTS Publications

Indexed Journals

NIL

Peer-reviewed Journals

NIL

Conferences

01. **Herath, R.J.** and Ishanka, P., 2022. An Approach to Sri Lankan Sign Language Recognition Using Deep Learning with MediaPipe. In *International Conference on Digital Technologies and Applications* (pp. 449-459). Springer, Cham.

02. **Hemachandra, K.G.R.P.**, Jayasena, K.P.N., Rankothge, W. and Wijesiri, M.P.M., 2022, February. Investigating the Performance in SDN Based Data Centers Under Different Network Topologies. In *2022 2nd International Conference on Advanced Research in Computing (ICARC)* (pp. 361-366). IEEE.

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04. **Ifham, M.**, Kumara, B.T.G.S. and Ekanayake, E.M.U.W.J.B., 2021, December. Ensemble learning approach to classify user defined functions in Java programs. In *2021 International Conference on Decision Aid Sciences and Application (DASA)* (pp. 533-537). IEEE.

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10. **Ranapana, R.A.A.I.B.** and Jayasena, K.P.N., 2021, December. Novel Approach for Load Balancing in Mobile Cloud Computing. In *2021 6th International Conference on Information Technology Research (ICITR)* (pp. 1-6). IEEE.

11. **Rathnayake, R.M.D.S.**, Kumara, B.T.G.S. and Ekanayake, E.M.U.W.J.B., 2021, December. CNN-Based Priority Prediction of Bug Reports. In *2021 International Conference on Decision Aid Sciences and Application (DASA)* (pp. 299-303). IEEE.

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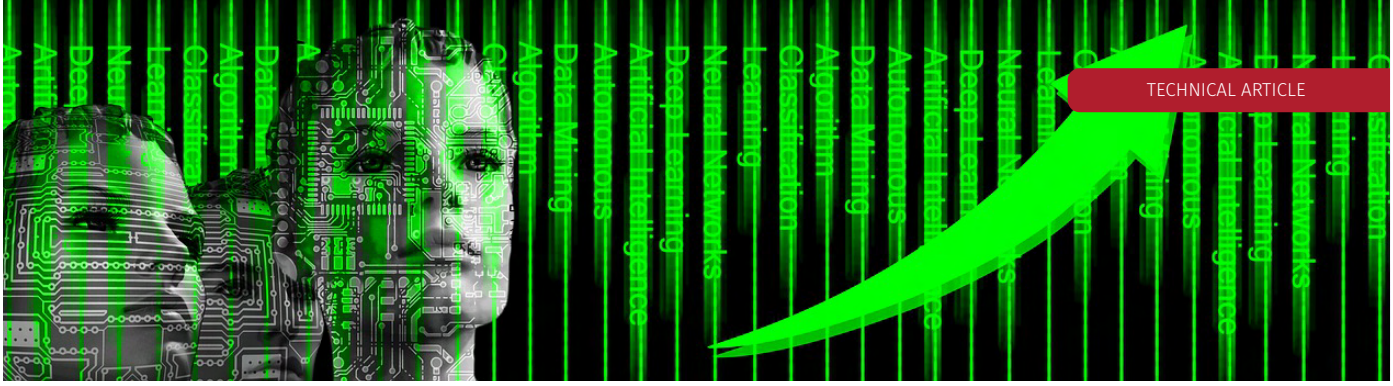

Deep Learning for Deep Fashion

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Fashion is about change, innovation, time, place, and the environment of those who wear it. At the heart of any definition of fashion clothing is the relationship between a design product and how it is distributed and consumed. People love fashion and want to know what is best and how to enhance their style and their personality. Now artificial intelligence-based systems are monitoring every sale and future trends in clothing. This can be done using machine learning and their integration with computer vision techniques. It is further improved by utilising deep neural networks inspired by the human brain, engaging in neuroscience via training suitable fashion models. These approaches use either structured or unstructured fashion clothing images to make computers to identify, classify, and match clothes. It is about designing a model that can tell you about the fashion clothing that comes in handy when demand increases for the recognition of clothing categories and its attributes.

For example, the results described in the fashion industries allow users to translate images into text, which can also be interpreted as clothing descriptions. Fashion analysis facilitates retrieval, synthesis, recommender systems, trend analysis, and production quality and inspection in a wide range. The overall fashion related tasks are depicted in Figure 1. In this regard, the fashion related tasks are three-fold: low-level pixel calculation, intermediate fashion understanding and high-level fashion analysis. Low-level pixel calculations are aimed at creating pixel-level labels on clothing images such as segmentation, clothing landmark detection and pose estimation, whereas intermediate fashion understanding aims to identify fashion images such as clothing categories, attributes, and styles. Advanced fashion analytics includes recommendations, fashion synthesis and fashion trend forecast.

Figure 1: *Different types of DR lesions*

Earlier fashion models mostly relied on hand-crafted features and hunt for powerful clothing depictions such as graph models, contextual information, general object proposals, human parts, bounding boxes, and semantic masks using different feature ranges of traditional feature extraction methods and image processing techniques including colour histograms, Local Binary Patterns (LBP), Histogram of Oriented Gradients (HOG), Scale-Invariant Feature Transform (SIFT), and many more. An evolving technique for clothing-related tasks is the deep learning method, which uses convolutional neural networks (CNNs) to simultaneously learn feature illustration and classify clothing-related images.

Deep learning methods show their power of automatically learning effective image representations to succeed in any object analysis tasks via different structures of deep neural networks. A trained clothing classification system facilitates automated fashion stylists, outfit recommendation, discovering similar fashion pieces, surveillance context, automatic annotation of images with tags or descriptions, context-aided people identification, occupation recognition, improvement in information retrieval from various

areas such as social medias, conversational bots for shopping assistance, personalised apparel recommendations, and fashion trend forecast [1].

Apart from that, the influence of computer vision in fashion and textiles refine some of the well-known technologies for textile defect detection and quality control, fashion recognition, and 3D modelling. Moreover, the high-quality large-scale data annotation is essential for effective feature engineering. However, current research is mainly based on relatively small-scale datasets, which are usually limited by annotation cost and workload.

Nevertheless, digital analysis in clothing images inherently endure difficulties based on variety of aspects such as deformation and occlusion of subjects, varieties in texture, style and cutting, different scenarios where the images taken from such as selfies and online shopping images, the available labelled image data size is small for clothing attribute, and the number of fine-grained attribute categories is also limited, and the existence of domain drift problem i.e., transferring models trained using clean shop images to recognise attributes in images captured in-the-wild from the streets.

Fashion clothing detection departs into the detection of clothing area using bounding box prediction and analysing important clothing landmarks to distinguish various clothing categories, whereas fashion clothing classification evolve into categorisation and clothing attribute prediction as shown in Figure 2. The main task of fashion landmark detection is to identify keypoints which are called clothing landmarks (i.e., hem, collar, sleeve, and waistline). How to locate and distinguish these fashion landmarks in clothing images are very important for many fashion related tasks.

Fashion landmark detection has been solved through various techniques such as regression, pose estimation-based methods, constraint-based methods, and as attentive knowledge for category classification. Though the performance shows improvement using fashion clothing landmark detection, the studies on landmarks are troublesome with error-prone and annotating landmarks is time consuming. It also suffers from unique differences in clothing items so that combining or grouping landmarks is crucial task. On that account, the effective feature engineering which learns discriminative feature representation becomes eminent part in fashion analysis.

Furthermore, in classification tasks, many visual attention mechanisms are used to improve the performance. Humans have an ability to focus and understand novel visual features in difficult scenarios which is called “visual attention”. Recent research focuses on the use of weighted-mask that combines in-depth learning and visual attention mechanisms [2],[3]. The use of weighted-mask in a model is to capture important features by another layer with newly learnt weights. For creating attention, the CNN can learn the areas to be focused on each feature map through learning.

Besides, attention mechanisms combine various structured spatial, semantic, and/or channel information that influences computer vision tasks. Conventionally, it is important to perform some fine-grained visual processing on images, and even multiple steps of inference to produce high quality output. Furthermore, the process of CNNs incorporates characteristics along spatial regions which are object dependent features and along channels which replicates the various representation of global image features (e.g., edges, colours, corners, texture, shape etc.).

For the fine representation of clothing items, multiple fashion clothing datasets have been created and published along with more practical focus such as DeepFashion dataset[1], Fashion landmark detection (FLD) dataset[2], and DeepFashion2 dataset[3]. Most of these benchmark datasets were collected from customer photos, selfies, and online clothing shopping websites and contain rich annotations. At the same time, the large amount of data generated by social media and e-commerce sites provides an opportunity to explore relevant knowledge to support the development of fashion models. Fashion data for clothing analysis are in large-scale, however, the success on annotated datasets is expensive due to a lot of human effort, pain and/or financial cost in creating such large datasets.

Hence, semi-supervised learning (SSL) [4] has proven to be a powerful paradigm to leverage unlabelled data to mitigate the reliance on large, labelled datasets by combining supervised and unsupervised

learning approaches. In classification tasks, supervised models attempt to perform well on labelled samples as determining upper leap to the predictions while SSL models reduce the ratio of labelled samples in training set.

1. https://mmlab.ie.cuhk.edu.hk/projects/DeepFashion/AttributePrediction.html

2. http://mmlab.ie.cuhk.edu.hk/projects/DeepFashion/LandmarkDetection.html

3. https://sites.google.com/view/cvcreative/deepfashion2

Figure 1: *Different types of DR lesions*

In this regard, the idea is to consider more efficient classification scenarios to satisfy the clothing related tasks involving the need of speed and reduced complexity. The main problem related to the performance of computer and capacity of memory for training the fashion model is still a long way from human performance in the real-world environment.

As a result, the need for more powerful systems has grown. Despite the latest improvements, modelling suitable fashion models continues to be a challenge for developing smart fashion solutions while exploring complex real-world problems. Also, with the growing interest in mobile applications, there is a need to make fashion models easier but timelier. Thus, it would also be beneficial to consider how to improve the model optimisation for greater efficiency and better computational efficiency.

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Congratualtions

Dr Thuseethan Selvarajah

The Department of Computing and Information Systems
takes pride in congratulating
Dr. Thuseethan Selvarajah
on his
PhD Graduation which took place on April 6th, 2022.
Dr. Thuseethan earned the Doctor of Philosophy Degree in Information Technology from the Deakin University, Australia.

We wish you continued strength to nurture our undergraduates through sharing and disseminating knowledge in your field of expertise

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ISSN 2773-725X
9 772773 725008