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การวิเคราะห์ข้อมูลเชิงลึกทางด้านทักษะคอมพิวเตอร์โดยใช้รูปแบบความสัมพันธ์ระหว่างรายวิชากับตำแหน่งงานทางด้านไอทีเพื่อขับเคลื่อนระบบอัจฉริยะทางด้านงานทรัพยากรบุคคล

THE INSIGHTS IN COMPUTER LITERACY TOWARD HR INTELLIGENCE: SOME ASSOCIATIVE PATTERNS BETWEEN IT SUBJECTS AND JOB POSITIONS

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บทคัดย่อ

เทคโนโลยีสารสนเทศ หรือ ไอที นั้นสามารถช่วยเพิ่มการเติบโตของธุรกิจสตาร์ทอัพแบบก้าวกระโดด (หรือที่เรียกว่า ยูนิคอร์น) โดยมีการดำเนินงานแบบดิจิทัลต่าง ๆ เพื่อบริการให้กับลูกค้า ซึ่งแสดงให้เห็นว่า ตำแหน่งงานทางด้านไอทีนั้น ยังคงมีความต้องการในตลาดแรงงาน เช่น ๑) นักพัฒนาซอฟต์แวร์ ๒) นักวิเคราะห์ระบบ ๓) นักออกแบบส่วนประสานกับผู้ใช้ ๔) ผู้จัดการโครงการ ๕) นักทดสอบซอฟต์แวร์ ๖) นักวิทยาการข้อมูล ๗) วิศวกรระบบเครือข่าย และ ๘) นักทดสอบความปลอดภัยคอมพิวเตอร์ ถ้าค้นข้อมูลระบบรับสมัครงานออนไลน์ชื่อดัง เช่น จ็อบท็อปกัน และจ็อบส์ดีบี อย่างไรก็ตาม นิสิตนักศึกษาชั้นปีที่ ๔ ยังขาดประสบการณ์ทำให้ไม่สามารถเลือกตำแหน่งงานทางไอทีที่เหมาะสมกับทักษะทางด้านคอมพิวเตอร์ของพวกเขาได้ บทความฉบับนี้สร้างสูตรหาความสัมพันธ์ระหว่างรูปแบบของรายวิชากับตำแหน่งงานทางด้านไอทีในรูปแบบกฎเกณฑ์ เสมือนเป็น ระบบสนับสนุนการตัดสินใจสำหรับนิสิตนักศึกษาชั้นปีที่ ๔ โดยที่รายวิชาทางด้านไอทีที่นำมาใช้ในการสร้างรูปแบบความสัมพันธ์นั้น ประกอบด้วย ๑) การเขียนโปรแกรมแบบโครงสร้าง ๒) การเขียนโปรแกรมแบบเชิงวัตถุ ๓) โครงสร้างข้อมูลและอัลกอริทึม ๔) วงจรดิจิทัล ๕) การวิเคราะห์และออกแบบระบบ ๖) การพัฒนาซอฟต์แวร์บนอุปกรณ์เคลื่อนที่กับเว็บไซต์ ๗) วิศวกรรมซอฟต์แวร์ ๘) การจัดการโครงการ ๙) การทดสอบซอฟต์แวร์ ๑๐) ระบบสารสนเทศเพื่อการจัดการ ๑๑) การพัฒนาเกมส์ ๑๒) เหมืองข้อมูล ๑๓) การเรียนรู้ของจักรกล ๑๔) ฐานข้อมูลกับ

วันที่รับบทความ *11 กรกฎาคม 2563*
วันแก้ไขบทความ *13 สิงหาคม 2563*
วันตอบรับบทความ *20 สิงหาคม 2563*

ข้อมูลขนาดใหญ่ ๑๕) การประมวลผลบนกลุ่มเมฆกับระบบปฏิบัติการ ๑๖) สถาปัตยกรรมคอมพิวเตอร์ ๑๗) คอมพิวเตอร์กราฟฟิกส์ ๑๘) ความปลอดภัยทางคอมพิวเตอร์ ๑๙) ระบบสมองกลฝังตัว และ ๒๐) เครือข่ายคอมพิวเตอร์ ตามลำดับ จะเห็นได้ว่าระบบสนับสนุนการตัดสินใจนี้เป็นเสมือน “ระบบอัจฉริยะทางด้านงานทรัพยากรบุคคล” สำหรับเลือกตำแหน่งงานทางด้านไอที ตามทักษะคอมพิวเตอร์ที่ตนเองถนัดได้อย่างเหมาะสม

คำสำคัญ: ระบบอัจฉริยะทางด้านงานทรัพยากรบุคคล การจับคู่ตำแหน่งงานทางด้านไอที ระบบสนับสนุนการตัดสินใจ การเรียนรู้รูปแบบความสัมพันธ์ของข้อมูล การวิเคราะห์ข้อมูลขนาดใหญ่

ABSTRACT

Information technology (IT) is able to increase the growth of start-up business by leaps and bounds (a.k.a. unicorn). Much type of operation adopts digital process as a business customer service. It appears that many IT job positions are required in the job market (e.g., 1) software developer, 2) system analyst, 3) UX/UI designer, 4) project manager, 5) software tester, 6) data scientist, 7) network engineer and 8) security specialist) from the online recruitment platforms (e.g., JOBTOPGUN and jobsDB). However, many inexperienced fourth year IT students cannot choose what IT job positions are really suitable for their IT skills (a.k.a. computer literacy). This paper formulates the association learning to discover the impact patterns between IT subjects and job positions as a rule-based decision support system for the fourth year IT students. All IT subjects are 1) structural programming, 2) object-oriented programming, 3) data structure and algorithm analysis, 4) digital circuits, 5) system analysis and design, 6) mobile and web development, 7) software engineering, 8) project management, 9) software testing, 10) management information systems, 11) games development, 12) data mining, 13) machine learning, 14) big data and database, 15) cloud and operating systems, 16) computer architecture, 17) computer graphics, 18) computer security, 19) embedded systems and 20) computer network, severally. In a nutshell, this system can be seen as the human resource intelligence that makes the new employees select their IT jobs according to computer literacy.

Keywords: HR intelligence, IT job matching, Decision support system, Association learning, Big data analytics

1. Introduction

In our disruptive world, information technology (IT) plays the main role as business competitiveness [1]. IT implementation is seen as a shorter way to accomplish any industries in terms of speed, accuracy, convenience or cost. Accordingly, most successful start-ups adopt digital processes to produce many different types of operational service within a short time as

their business reliabilities [2]. It is not surprise that why IT has a wide branch of knowledge groups: software engineering [3], games development [4], big data [5], authentication [6-7], medical and healthcare informatics [8-9], geo-informatics [10-12], Image forensics [13], cultural image tagging [14-16], GPS-based intelligence [17-19], gesture recognition [20-21], facial attributes [22], tourism scene classification [23-24], cloud-based computer systems [25-26], signal processing [27], image analytics [28], and internet of things [29], etc. As well as the age of business intelligence (BI) that many modern AI-based applications are implemented: deep learning [30], image classification [31-33], natural language processing [34], optimization search [35-36] and QA robots [37-38].

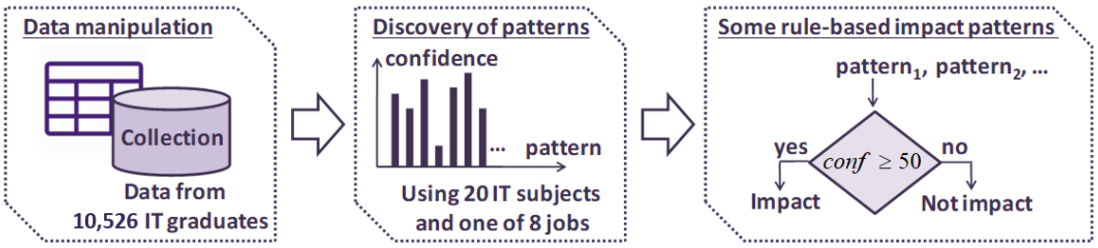

Figure 1 The impact pattern discovery between IT subjects and job positions

As for the online recruitment platforms (e.g., JOBTOPGUN and jobsDB), many available IT job positions are required [28]: 1) software developer, 2) system analyst, 3) UX/UI designer, 4) project manager, 5) software tester, 6) data scientist, 7) network engineer and 8) security specialist, etc. IT major consists of computer engineering, computer science, information technology, business computer and management information systems. Unfortunately, most inexperienced IT students (e.g., computer science, information technology, business computer and computer engineering) who never work in any IT industries and also do not know those IT job descriptions [39-41] In a nutshell, they cannot choose what IT job positions are really suitable for their IT skills (a.k.a. computer literacy).

In this paper, we design a decision support system for the fourth year IT students by discovering the impact patterns between 20 IT subjects (as the IT skills) and 8 job positions (as the suitable jobs) from the list of 10,526 graduates, as shown in figure 1. All IT subjects consist of 1) structural programming, 2) object-oriented programming, 3) data structure and algorithm analysis, 4) digital circuits, 5) system analysis and design, 6) mobile and web development, 7) software engineering, 8) project management, 9) software testing, 10) management information systems, 11) games development, 12) data mining, 13) machine learning, 14) big data and database, 15) cloud and operating systems, 16) computer architecture, 17) computer graphics, 18)

computer security, 19) embedded systems and 20) computer network. Our rule-based patterns are mathematically modeled by association learning.

The organization of this paper consists of 5 parts. Data manipulation is in part 2. Part 3 and 4 describe discovery of the patterns and some rule-based impact patterns. And the part 5 is conclusion.

2. Data manipulation

Some frequent asked questions (FAQs) from IT students are arisen as what job they should do?; what organizations provide high salary?; what the different job descriptions between developer and tester?; or what suitable job for them is? etc. In fact, IT expertness can be observed by what the student's strength/goodness is. To answer those FAQs by the statistical records, this paper formulates the rule-based association model from the data collection that contains of 10,526 graduates.

Each record consists of 20 IT subjects (1) structural programming (SP), 2) object-oriented programming (OP), 3) data structure and algorithm analysis (DA), 4) digital circuits (DC), 5) system analysis and design (AD), 6) mobile and web development (MW), 7) software engineering (SE), 8) project management (PJ), 9) software testing (ST), 10) management information systems (IS), 11) games development (GD), 12) data mining (DM), 13) machine learning (ML), 14) big data and database (BD), 15) cloud and operating systems (CO), 16) computer architecture (CA), 17) computer graphics (CG), 18) computer security (CS), 19) embedded systems (ES) and 20) computer network (CN),; and one of the 8 jobs (1) software developer (SD), 2) system analyst (SA), 3) UX/UI designer (UD), 4) project manager (PM), 5) software tester (TT), 6) data scientist (DS), 7) network engineer (NE) and 8) security specialist (SC). By the way, the grades of IT subjects can be A, B+, B, C+,C, D+ and D, severally.

3. Discovery of the patterns

All rows (consists of 20 IT subjects and one of 8 jobs) of the collection are used to find the association between IT subjects and job positions [41] as the frequent pattern discovery. Association learning [41-42] is a rule-based model for finding the association between parameters. Some works discovered the insights by factor analysis, e.g., effect of IT students in full-time job [43] and effects on learning performance of students using social media [44]. To this end, the insights can be mined by the frequent patterns between IT subjects and job positions.

To give an example, assuming S as the *sample space*, the set $ML_{(A)}$ as *grade A in machine learning* and DS as *data scientist* that both $ML_{(A)}$ or DS are the subsets of S. The relation between $ML_{(A)}$ and DS is called *support*, mathematically defined by (1), where ϕ as an empty set.

$$\left((ML_{(A)} \subset S) \cap (DS \subset S)\right) \rightarrow \left((ML_{(A)} \cap DS) \not\subset \phi\right) \quad (1)$$

Such an association that "*if the student gets 'A' in Machine Learning ($ML_{(A)}$), then the IT job is Data Scientist (DS)*" is basically defined by (2).

$$IT_{job} = \langle DS \rangle,\ if\ ML_{(A)};\ conf = \frac{n\left(ML_{(A)} \cap DS\right)}{n\left(ML_{(A)}\right)} \times 100 \quad (2)$$

The association is indicated by *confidence* $\left(conf = \frac{n\left(ML_{(A)} \cap DS\right)}{n\left(ML_{(A)}\right)} \times 100 \right)$, where $n(\bullet)$ as a number of members within the set.

4. Some rule-based impact patterns

The implementation is done by PyCaret's module. For discovery of the impact patterns between IT subjects and job positions, the confidence acceptance is set as ***equal or greater than 50%*** ($conf \geq 50$) that can be applied to active learning [45] in IT classroom for student guideline. The accepted associative rules are classified as their 8 job positions.

4.1 Software developer

As the associative linkage in (3), mobile and web development (MW), games development (GD), system analysis and design (AD) have the impact patterns to software developer (SD). Since these subjects totally concerns the programming skills in depth. Surprisingly, digital circuits (DC) also have the association to this position that the subject may concern digit computation and logical thinking.

$$IT_{job} = \langle SD \rangle,\ if \begin{cases} MW_{(A)} \cup MW_{(B+)};\ conf = 92\% \\ GD_{(A)};\ conf = 83\% \\ (DC_{(A)} \cup DC_{(B+)}) \cap MW_{(B)};\ conf = 75\% \\ (GD_{(B+)} \cup GD_{(B)} \cup GD_{(C+)}) \cap (AD_{(A)} \cup AD_{(B+)});\ conf = 63\% \end{cases} \quad (3)$$

4.2 System analyst

This job position needs to draw a diagram showing the relation between entities. The associative rules from (4) consequently are big data and database (BD), system analysis and design (AD) and software engineering (SE). Moreover, object-oriented programming (OP) refers to programming in a large-scale system that needs to class division and developing teamwork.

$$IT_{job} = \langle SA \rangle,\ if \begin{cases} BD_{(A)} \cup BD_{(B+)};\ conf = 86\% \\ AD_{(A)} \cap (BD_{(B)} \cup BD_{(C+)});\ conf = 77\% \\ (SE_{(B+)} \cup SE_{(B)}) \cap OP_{(C+)};\ conf = 72\% \\ SE_{(A)} \cap OP_{(B+)};\ conf = 67\% \\ (OP_{(A)} \cup OP_{(B)}) \cap AD_{(B)};\ conf = 52\% \end{cases} \quad (4)$$

4.3 UX/UI designer

This job has a less number from our collection. Most UX/UI designers (UD) understand the workflow of software coupled with the step of usage and user-friendliness. However, most of them do not have the high grade in programming or network subjects. The related subjects are system analysis and design (AD), software engineering (SE), object-oriented programming (OP), computer graphics (CG) and structural programming (SP), as defined by (5).

$$IT_{job} = \langle UD \rangle,\ if \begin{cases} SE_{(C+)} \cup (AD_{(B+)} \cup AD_{B} \cup AD_{C+});\ conf = 76\% \\ OP_{(C+)} \cap SE_{(C+)};\ conf = 68\% \\ (CG_{(A)} \cup CG_{(C+)}) \cap SP_{(C+)};\ conf = 66\% \\ OP_{(B)} \cap (SP_{(B)} \cup SP_{(C+)});\ conf = 57\% \\ OP_{(C+)} \cap SP_{(C+)} \cap (CG_{(B)} \cup CG_{(C+)});\ conf = 50\% \end{cases} \quad (5)$$

4.4 Project manager

By (6), project manager (PM) needs both technical skills and business vision. Most important e-business subjects are project management (PJ) and management information systems (IS). Some technical skills are also concerned: system analysis and design (AD), software engineering (SE) and object-oriented programming (OP).

$$IT_{job} = \langle PM \rangle,\ if \begin{cases} PJ_{(A)} \cup PJ_{(B+)} \cup PJ_{(B)};\ conf = 96\% \\ IS_{(A)} \cup IS_{(B+)} \cup IS_{(B)};\ conf = 94\% \\ (SE_{(A)} \cup SE_{(B+)} \cup SE_{(B)}) \cap (AD_{(B)} \cup AD_{(C+)});\ conf = 87\% \\ (PJ_{(A)} \cap IS_{(A)}) \cap (AD_{(C+)} \cup OP_{(C+)});\ conf = 81\% \end{cases} \quad (6)$$

4.5 Software tester

From the collection, software tester is one of the most interesting jobs. Most students misunderstand the software tester (TT) that does not require programming skills. Actually, the software tester needs to write a script to test the correctness of software [46]. From the discovery, the related subjects are software testing (ST), software engineering (SE), data structure and algorithm analysis (DA), structural programming (SP) and computer security (CS) as (7). Surprisingly, some of them have high grades in programming subjects; it shows that software tester also requires programming skills as well as software developer.

$$IT_{job} = \langle TT \rangle,\ if \begin{cases} ST_{(A)} \cup ST_{(B+)};\ conf = 94\% \\ SE_{(A)} \cap ST_{(A)};\ conf = 91\% \\ (ST_{(B)} \cup ST_{(C+)}) \cap (SP_{(B+)} \cup SP_{(B)} \cup SP_{(C+)});\ conf = 84\% \\ ST_{(A)} \cap (DA_{(A)} \cup DA_{B+}) \cap (SP_{(B)} \cup SP_{(C+)});\ conf = 77\% \\ ST_{(A)} \cap (CS_{(A)} \cup CS_{(B+)});\ conf = 70\% \\ SP_{(B+)} \cap ST_{(A)};\ conf = 66\% \\ SE_{(C+)} \cap ST_{(C+)} \cap DA_{(B+)} = 59\% \\ (CS_{(B)} \cup CS_{(C+)}) \cap (DA_{(B)});\ conf = 51\% \end{cases} \quad (7)$$

4.6 Data scientist

Data scientist (DS) – a new IT position requires statistical and programming skills (as 8). The AI and data science subjects consist of data mining (DM) and machine learning (ML). For data engineering, cloud and operating system (CO) and big data and database (BD) are required for centralized/decentralized big data infrastructures and platforms. Logical thinking and programming are also related to data structure and algorithm (DA) and digital circuits (DC).

$$IT_{job} = \langle DS \rangle,\ if \begin{cases} DM_{(A)} \cup ML_{(A)};\ conf = 96\% \\ DM_{(A)} \cup DM_{(B+)} \cup DM_{(B)};\ conf = 92\% \\ (ML_{(B+)} \cup DM_{(B+)}) \cap (BD_{(A)} \cup BD_{(B+)});\ conf = 88\% \\ ML_{(B)} \cap (DC_{(A)} \cup DC_{(B+)} \cup DC_{(B)});\ conf = 84\% \\ CO_{(A)} \cap ML_{(B+)} \cap BD_{(B)};\ conf = 78\% \\ DA_{(C+)} \cap DM_{(B+)} \cap (DC_{(B+)} \cup DC_{(B)});\ conf = 67\% \\ DA_{(A)} \cap DM_{(A)} \cap ML_{(A)} \cap DC_{(A)};\ conf = 50\% \end{cases} \quad (8)$$

4.7 Network engineer

From (9), this job needs to know the overall system linkage that covers the 7 layers of OSI model, hardware architecture, routing algorithms and cloud platforms. Consequently, all

subjects are data structure and algorithm analysis (DA), digital circuits (DC), big data and database (BD), cloud and operating systems (CO), computer architecture (CA), computer security (CS), embedded systems (ES) and computer network (CN).

$$IT_{job} = \langle NE \rangle,\ if \begin{cases} (CA_{(A)} \cup CA_{(B+)} \cup CA_{(B)};\ conf = 81\% \\ CN_{(A)} \cup CN_{(B+)};\ conf = 76\% \\ ES_{(A)} \cap CN_{(A)} \cap CA_{(A)} \cap DC_{(A)};\ conf = 65\% \\ DA_{(C+)} \cap (BD_{(B+)} \cup BD_{(B)} \cup BD_{(C+)});\ conf = 57\% \\ (CS_{(B)} \cup BD_{(C+)}) \cap ES_{(B+)};\ conf = 54\% \\ (DA_{(A)} \cup DA_{(B+)}) \cup (DC_{(A)} \cup DC_{(B+)});\ conf = 50\% \end{cases} \quad (9)$$

4.8 Security specialist

Security specialist (SC) sometimes looks like the software tester who tests the software before its employment. This job has a responsibility to test the security of entire information system with its connections. The important key subjects are related to data structure and algorithm analysis (DA), digital circuits (DC), big data and database (BD), cloud and operating systems (CO), software testing (ST), computer security (CS), and computer network (CN), as (10).

$$IT_{job} = \langle SC \rangle,\ if \begin{cases} CS_{(A)} \cap (DA_A \cup DA_{(B+)});\ conf = 79\% \\ (BD_{(B)} \cup BD_{(C+)}) \cap DA_{(C+)} = 73\% \\ ST_{(A)} \cap DC_{(A)} \cap CO_{(A)} = 68\% \\ (CN_{(A)} \cup CN_{(B+)}) \cap CS_A = 60\% \\ (DA_{(B+)} \cup DA_{(C+)}) \cap (CS_{(B+)} \cup CS_{(B)}) = 57\% \end{cases} \quad (10)$$

5. Conclusion

Since information technology (IT) is the full lineup to increase the growth of business by leaps and bounds. Many IT job positions are available on the online recruitment. As it is under the problem in human resource department that many in experienced students do not know what IT job positions are suitable for them? Many graduates spend 2-3 or longer than 5 years to find the suitable positions according to their abilities. This paper discovers the impact patterns between IT subjects and job positions using association learning. All rule-based patterns are formulated by matching between 20 IT subjects: 1) structural programming, 2) object-oriented programming, 3) data structure and algorithm analysis, 4) digital circuits, 5) system analysis and design, 6) mobile and web development, 7) software engineering, 8) project management, 9) software testing, 10) management information systems, 11) games development, 12) data mining,

13) machine learning, 14) big data and database, 15) cloud and operating systems, 16) computer architecture, 17) computer graphics, 18) computer security, 19) embedded systems and 20) computer network; with one of 8 job positions:) software developer, 2) system analyst, 3) UX/UI designer, 4) project manager, 5) software tester, 6) data scientist, 7) network engineer and 8) security specialist. For the measurement, the rule confidence is accepted at 50%. In a nutshell, the discovery of rule-based patterns is able to be used as a web-based decision support system for IT students that drive the future human resource intelligence. The students use these rules as a guidance to investigate their subject grades and IT skills to select the job positions by comparing to those historical patterns. For more intelligence, the AI can autonomously select the appropriate job for the students using only their transcript by natural language processing on the large-scale textual information.

6. Reference

[1] Man, R. (2019). How Growth Teams Are Built and Managed At UiPath, One Of The Biggest Artificial Intelligence Startups. Retrieved 2019, from https://magazine.startus.cc/growth-teams-built-managed-uipath-one-biggest-artificial-intelligence-startups/

[2] Spiegel, D. (2019). 100 of the world's most promising start-ups to watch in 2019. Retrieved 2019, from https://www.cnbc.com/2019/11/12/100-of-the-worlds-most-promising-start-ups-to-watch-in-2019.html

[3] Ghazi, N. A., Petersen, K., Reddy, R. S., and Nekkanti, H. (2019). Survey Research in Software Engineering: Problems and Mitigation Strategies. IEEE Access. 7, 24703-24718.

[4] Borg, M., Garousi, V., Mahmoud, A., Olsson, T., and Stalberg, O. (2019). Video Game Development in a Rush: A Survey of the Global Game Jam Participants. IEEE Transactions on Games. Early Access, 1-1.

[5] Lu, R., Jin, X., Zhang, S., Meikang, Q., and Wu, X. (2018). A Study on Big Knowledge and Its Engineering Issues. IEEE Transactions on Knowledge and Data Engineering. 31(9), 1630 - 1644.

[6] Soimart, L., and Mookdarsanit, P. (2016). Multi-factor Authentication Protocol for Information Accessibility in Flash Drive. The 9th International Conference on Applied Computer Technology and Information Systems. Nakhon Pathom, Thailand.

[7] Mookdarsanit, L. and Mookdarsanit, P. (2020). Adversarial Perturbation Technique against reCaptcha Image Attacks. Journal of Science and Technology Buriram Rajabhat University. 4(1).

[8] Safa, B., Zoghlami, N., Abed, M., and Tavares, R. S. (2018). Big Data for Healthcare: A Survey. IEEE Access. 7, 7397 - 7408.

[9] Sutthaluang, N. (2018). The Impact of Asbestos Exposure on Lung Disease. The 15th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology, (pp. 353-355). Chiang Rai, Thailand.

[10] Soimart, L., and Ketcham, M. (2016). An Efficient Algorithm for Earth Surface Interpretation from Satellite Imagery. Engineering Journal. 20(5), 215-228.

[11] Soimart, L., and Ketcham, M. (2016). The Segmentation of Satellite Image using Transport Mean-shift Algorithm. The 13th International Conference on IT Application, (pp. 124-128). Phitsanulok, Thailand.

[12] Soimart, L., and Ketcham, M. (2016). Hybrid of Pixel-based and Region-based Segmentation for Geology Exploration from Multi-spectral Remote Sensing. The 11th International Symposium on Natural Language Processing. Ayutthaya, Thailand.

[13] Mookdarsanit, P., Soimart, L., Ketcham, M., and Hnoohom, N. (2015). Detecting image forgery using XOR and determinant of pixels for image forensics. The 11th International Conference on Signal-Image Technology & Internet-Based Systems, (pp. 613-616). Bangkok, Thailand.

[14] Mookdarsanit, L. (2020). The Intelligent Genuine Validation beyond Online Buddhist Amulet Market. International Journal of Applied Computer Technology and Information Systems. 9(2), 7-11.

[15] Mookdarsanit, P. and Rattanasiriwongwut, M. (2017). MONTEAN Framework: A Magnificent Outstanding Native-Thai and Ecclesiastical Art Network. International Journal of Applied Computer Technology and Information Systems, 6(2), 17-22.

[16] Mookdarsanit, P. and Rattanasiriwongwut, M. (2017). GPS Determination of Thai-temple Arts from a Single Photo. The 11th International Conference on on Applied Computer Technology and Information Systems, Bangkok, Thailand, (pp. 42-47). Thailand.

[17] Mookdarsanit, P., and Ketcham, M. (2016). Image Location Estimation of Well-known Places from Multi-source based Information. The 11th International Symposium on Natural Language Processing. Ayutthaya, Thailand.

[18] Mookdarsanit, P., and Rattanasiriwongwut, M. (2017). Location Estimation of a Photo: A Geo-signature MapReduce Workflow. Engineering Journal. 21(3), 295-308.

[19] Dolev, S., Florissi, P., Gudes, E., Sharma, S., and Singer, I. (2019). A Survey on Geographically Distributed Big-Data Processing Using MapReduce. IEEE Transactions on Big Data. 5(1), 60 - 80.

[20] Mookdarsanit, P., and Mookdarsanit, L. (2018). An Automatic Image Tagging of Thai Dance's Gestures. Joint Conference on ACTIS & NCOBA, (pp. 76-80). Ayutthaya, Thailand.

[21] Mookdarsanit, P. and Mookdarsanit, L. (2018). A Content-based Image Retrieval of Muay-Thai Folklores by Salient Region Matching. International Journal of Applied Computer Technology and Information Systems, 7(2), 21-26.

[22] Soimart, L. and Mookdarsanit, P. (2016). Gender Estimation of a Portrait: Asian Facial-significance Framework. The 6th International Conference on Sciences and Social Sciences. Mahasarakham, Thailand.

[23] Soimart, L. and Mookdarsanit, P. (2017). Name with GPS Auto-tagging of Thai-tourist Attractions from An Image. The 2nd Technology Innovation Management and Engineering Science International Conference (pp. 211-217). Nakhon Pathom, Thailand.

[24] Mookdarsanit, P., and Mookdarsanit, L. (2018). Contextual Image Classification towards Metadata Annotation of Thai-tourist Attractions. ITMSoc Transactions on Information Technology Management, 3(1), 32-40.

[25] Mookdarsanit, P., and Gertphol, S. (2013). Light-weight Operation of A Failover System for Cloud Computing. The 5th International Conference on Knowledge and Smart Technology, (pp. 42-46). Chonburi, Thailand.

[26] Menouer, T., Sukhija, N., and Darmon, P. (2019). Towards A Parallel Constraint Solver for Cloud Computing Environments. IEEE Fifth International Conference on Big Data Computing Service and Applications, (pp. 195-198). Newark, CA, USA.

[27] Sutthaluang, N. (2019). An Open Library Development for Pesticide Residue Analytics in Vegetables. International Journal of Applied Computer Technology and Information Systems. 8(2), 31-36.

[28] Mookdarsanit, L., and Mookdarsanit, P. (2019). Thai Herb Identification with Medicinal Properties Using Convolutional Neural Network. Suan Sunandha Science and Technology Journal. 6(2), 34-40.

[29] Song, H., Liang, H.-N., Liu, L., Ma, J., and Huang, X. (2019). A Hybrid Data Security System of Internet of Things. IEEE 4th International Conference on Big Data Analytics, (pp. 269-273). Suzhou, China.

[30] Gheisari, M., Wang, G., and Bhuiyan, M. Z. (2017). A Survey on Deep Learning in Big Data. The 2017 IEEE International Conference on Computational Science and Engineering and IEEE International Conference on Embedded and Ubiquitous Computing , (pp. 173-180). Guangzhou, China.

[31] Mookdarsanit, L., and Mookdarsanit, P. (2019). SiamFishNet: The Deep Investigation of Siamese Fighting Fishes. International Journal of Applied Computer Technology and Information Systems. 8(2), 40-46.

[32] Mookdarsanit, P., and Mookdarsanit, L. (2018). Name and Recipe Estimation of Thai-desserts beyond Image Tagging. Kasem Bundit Engineering Journal. 8(Special Issue), 193-203.

[33] Soimart, L., and Mookdarsanit, P. (2017). Ingredients Estimation and Recommendation of Thai-foods. SNRU Journal of Science and Technology. 9(2), 509-520.

[34] Mookdarsanit, P., and Mookdarsanit, L. (2019). TGF-GRU: A Cyber-bullying Autonomous Detector of Lexical Thai across Social Media. NKRAFA Journal of Science and Technology. 15(1), 50-58.

[35] Mohammadi, G. F., Amini, M. H., and Arabnia, H. R. (2019). Evolutionary Computation, Optimization and Learning Algorithms for Data Science. arXiv:1908.08006.

[36] Soimart, L., and Pongcharoen, P. (2011). Multi-row Machine Layout Design using Aritificial Bee Colony. The 2011 International Conference on Economics and Business Information. Bangkok, Thailand.

[37] Antol, S., Agrawal, A., Lu, J., Mitchell, M., Batra, D., Zitnick, C. L., and Parikh, D. (2015). VQA: Visual Question Answering. The 2015 IEEE International Conference on Computer Vision, (pp. 2425-2433). Araucano Park, Las Condes, Chile.

[38] Chaisittiporn, R. (2018). Service Boy Robot Path Planner by Deep Q Network. International Journal of Applied Computer Technology and Information Systems. 8(1), 50-61.

[39] Zhang, W., Hu, F., and Xie, Q. (2018). Design, Development and Application of Big Data Platform on Provision of Job Information Search Services for Students in Vocational College. The 7th International Conference of Educational Innovation through Technology, (pp. 180-183). Auckland, New Zealand.

[40] Phaphuangwittayakul, A., Saranwong, S., Panyakaew, S., Inkeaw, P., and Chaijaruwanich, J. (2018). Analysis Of Skill Demand In Thai Labor Market From Online Jobs Recruitments Websites. The 15th International Joint Conference on Computer Science and Software Engineering, (pp. 1-5). Nakhon Pathom, Thailand.

[41] Soimart, L., and Mookdarsanit, P. (2016). An Admission Recommendation of High-school Students using Apriori Algorithm. The 6th International Conference on Sciences and Social Sciences. Mahasarakham, Thailand.

[42] Solanki, S. K., and Patel, J. T. (2015). A Survey on Association Rule Mining. The 5th International Conference on Advanced Computing and Communication Technologies, (pp. 212-216). Haryana, India.

[43] Phakdi, P. (2015). The Effect and Consequences of Student in Information Technology Major Engaging Full-Time Job Employment during the Period of Study. International Journal of Applied Computer Technology and Information Systems. 3(2), 16-19.

[44] Thanuttamanon, B. and Onputtha, S. (2019). The Effect of Motivation, Behavior and Confidence on Learning Performance of Students in the Faculty of Business Administration, RMUTT, in Learning English through Social Media. International Journal of Applied Computer Technology and Information Systems. 9(1), 20-28.

[45] Sawangsri, B. (2018). The influence of Active Teaching on Learning Achievement. Journal of Science and Technology RMUTSB. 2(1), 36-39.

[46] Prakancharoen, S. and Sutthaluang, N. (2019). Software Quality Prediction by using Structural Equation Model. International Journal of Applied Computer Technology and Information Systems. 9(1), 63-67.