LP Based Integration of Computer Network and Security in University College

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Abstract. There is a need on incorporating computing with network and security teaching in University College. In this paper, a framework is proposed for integrating computer network and security teaching using Logic Programming. Two 5-sessions incorporation modules on computer network and security for 1st, 2nd, and 3rd year students were developed and implemented. Pre- and post- tests, class observations and interviews prove the framework viability in terms of 1) development and execution of the modules, and 2) the students’ learning outcomes on computer network and security content and Computational Thought, and the acceptance of the incorporation.

1. Introduction

Computing involves the study of computers and applications. In order to effectively assure the integrity and privacy of data and information, individuals should focus on computer network and security. [1] There is a necessity of incorporating computing, primary to the exercise of all other Computer Network and Security fields, in teaching and learning in University College (first to third year). Yet, not much is recognized on how great Computational Thought (CT) can be taught and how to incorporate it with Computer Network and Security fields to upgrade CT learning in third year University College in particular.

It is needed to come up with frameworks on how CT can be incorporated to Computer Network and Security niche to support both curricular topics and students’ learning outcomes.

In this article, a Logic Programming (LP) based framework for incorporation is proposed, named LPCNS. LPCNS accomplishes an integration of CT and Computer Network and Security niche by developing computer models for problems via Answer Set Programming (ASP) [2] – a contemporary LP model. LPCNS is derived from the subsequent point of view. It permits students to begin building interesting computer models, computer network and a security problem subsequent to a very brief beginning and so far it is a complete programming model. Second, LP ease the basic skills and topics in computer network and security due to the truth that LP is derived from findings and thoughts of Logic which outline a significant foundation for learning and problem solving in every computer network and security fields. The LP modeling method permits a native and relation of area under discussion theories and logic to computer model development. Thirdly, tertiary students are cognitively prepared for LP based style. Finally, for computer network and security, LPCNS facilitates students to develop fundamental skills, for instance raising questions and describing problems,
forming clarification, take in disagreement, and sharing information. For Computing, students will obtain abundant chances to study and practice numerous degrees of abstraction, problem solving, programming and communication as recognized in the Computer Science Framework [3].

The remainder of the paper is structured as happen next. The LPCNS framework is presented in Section 2. In Section 3, the research design of the viability of LPCNS is introduced and the process of data gathering and analysis. In section 4, the data in alliance with the research question is presented. The paper is concluded in the final section.

2. Hypothetical Framework

2.1. LP based Incorporation of Computer Network and Security

To incorporate Computer Network and Security teaching, a methodology has been employed with two (frequently iterative) chronological mechanisms: (1) Problem Narrative. Students are taught with a novel or learned Computer Network and Security topic (problem). Students are likely to respond simple questions in this topic and comprehend why; (2) Modelling. Request students to develop a computer model by means of LP. The model is likely to solve the questions in the problem narratives.

Data connection will be used as an instance to show both the method and LP.

Problem narrative. Data Connection is a topic taught in a university college. Think about three attributes with file type, data structure, and transmission mode. Typical questions include “Q1: does the transmission mode is an attribute of client?” and “Q2: what would happen if client does not define the transmission mode?” Students are likely to go through and study data connection and how these questions can be solved.

Modelling. In order to create a computer model and to solve the questions above, LP modelling method which consists of two actions are followed. (1) Find objects and relations in the problem. (2) Identify knowledge in the problem and compose LP rules for this knowledge. The last LP rules, also known as a program, outline the problem model.

Objects of the data connection problem. The objects at this point are three attributes of communication, data structure, file type, and transmission mode. Notice that each attributes is considered as an object here.

Relations in the data connection problem. As of question Q1, a relation of the structure attribute\((X, Y)\) has been identified indicating that member of \(X\) is an attribute of client \(Y\). Within question Q2, a relation nottransferred\((X)\) has been introduced which suggests that \(X\) is not transferred.

Knowledge and LP Rules. In this segment, the computer network knowledge required is explained to solve the questions in English and after that “convert” that knowledge into LP rules. For instance, in the given data connection, “a file type is an attribute of a client”, which can be converted, using the relation presented beforehand, into

\[ r1: \text{attribute(filetype,client)}. \]

which is named a fact, a minimal structure of LP rule. \(r1\) is the marker of the rule which perhaps referred to soon. Likewise, the knowledge “data structure is an attribute” and “transmission mode is an attribute” which are converted correspondingly into the facts: \(r2: \text{attribute(datastructure,client)}\) and \(r3: \text{attribute(transmissionmode,client)}\). The rules set above outlines a LP program which can be employed to solve question Q1: A query attribute(filetype,\(X\)), where \(X\) is a variable (in the typical
perceive of a variable in algebra or mathematics), requests the program to retrieve the attribute(\( X \)) that the file type in the data connection attribute. The right solution are data structure, file type and transmission mode. Figure 1 - 3 give an idea of SWI-Prolog 8.3.10, an open release of Prolog (https://www.swi-prolog.org/download/devel) [4]. Figure 1 is an editor having the program above, and Figure 2 holds the query attribute(filetype,\( X \)). While the Enter key is pressed, the answers are revealed in Figure 3.

![Figure 1: Print screen of SWI-Prolog 8.3.10](image1)

![Figure 2: Query](image2)

![Figure 3: Answer](image3)

To solve question Q2, the knowledge that file are not transferred is added which is represented as \( r4: \text{nottransferred(file)} \). Some more general knowledge also needed: “a file is not transferred if one of the attribute is not define.” This knowledge can be denoted by a LP rule of the structure: \( r5: \text{nottransferred}(X) :- \text{attribute}(X,Y), \text{nottransferred}(Y) \) where the characters “;:” is comprehend as “implies.” The rule is read from left to right as for whichever file \( X \), \( X \) is not transferred if \( X \) is an attribute of \( Y \) and \( Y \) is not transferred. (Remark: the rule is a precise version of the knowledge in data connection, but need to be polished when a data web is modelled.) With these recently additional rules, the LP program wraps up that file is not transferred too.

Nearly all main forms of ASP have been covered. The instances are hoped to show the straightforwardness of ASP and the genuineness of the modelling and how the modelling concentrates on area knowledge. Individual can too perceive that LP, in conjunction with its modelling method, creates an incorporation of Computer Network and Security.
2.2. LPCNS ease Computer Network and Security Learning

Practical learning are well recognized in computer network and security education. It is renowned as an efficient method to assist students better comprehend the theory of network and security [5]. In order to show how LP-based integration will ease computer network and security learning, the Program Learning Outcomes for Bachelor of Computer Science and Computer Network Security is used [6].

The nine outcomes: PLO1: Ability to apply current knowledge and adapt to emerging application in any related field of computer science, networking and security. (KNOWLEDGE) PLO2: Ability to use current techniques, skills and tools in any related field of computer science, networking, and security. (PRACTICAL SKILLS) PLO3: Ability to identify, analyse and apply critical thinking skills to troubleshoot and solve technical problems. (CRITICAL THINKING, PROBLEM SOLVING) PLO4: Ability to communicate effectively in written and oral form. (COMMUNICATION SKILL) PLO5: Ability to demonstrate teamwork, managerial, interpersonal and social skill effectively. (TEAMWORK) PLO6: Ability to adopt professionalism with social and ethical considerations in line with ethical and legal philosophies. (MORAL, PROFESSIONALISM AND ETHICS) PLO7: Ability to apply skills and philosophies of lifelong learning in educational and profession development. (LIFE LEARNING AND INFORMATION MANAGEMENT) PLO8: Ability to develop entrepreneurial skills in the related discipline and real world perspective. (ENTREPRENEURSHIP) PLO9: Ability to analyse and plan in leadership responsibility. (LEADERSHIP)

LPCNS is able to cover some of the nine outcomes. LPCNS is determined by developing computer models for computer network and security problems and therefore PLO2 will be practiced intensively underneath the incorporation method. In LPCNS, as exposed in Section 2.1, students are expectant to identify the knowledge and denote it as rules for computer models. Thus, PLO3 is addressed in the incorporation. As required in LP modelling method, students must detect the knowledge employed in modelling, convey it in English and after that convert it into exact rules. Thus, the incorporation assists students to exercise PLO4 (communication skill).

3. Study Design

In order to learn the viability of LPCNS, two LP-incorporated modules and used the probing case study approach to guide the investigation of the effectiveness of the modules [7].

3.1. Partakers and Background

This lesson occurred in a major (core) classes, by the name “Artificial Intelligence”, of a university college with 13 students in 1st – 3rd year which is situated in a city in Malaysia. The partakers were one computer science lecturer and her 1 class of 2 1st year, 9 2nd year and 2 3rd year students. Among the 1st, 2nd, (and 3rd respectively) students, there were 2, 8 (and 1) males and 0, 1, (and 1) females.

3.2. LP Based Incorporation Modules and Execution

A computer network (routing table) and security module (traditional cipher) are developed.

3.2.1. Computer Network Module. Lesson 1 presents computer models in particular. The theory of LP based computer models for problem solving is introduced. Students would cooperate by raising the similar questions raised in the class and expanding the model with novel knowledge.

Lesson 2 presents LP theories of facts, queries and relations by means of instances. It initially goes through the router symbols. Students will therefore extends a specified model by totting up facts, for instance on the symbol for Router. The students initially key in a comment “% The symbol for Router 1 is R1” and after that the fact “symbolFor(router1,r1).” Queries are presented
to respond questions to the model. Students therefore expand the model with knowledge as of other router as well as Router 2, and test the model by means of queries.

Lesson 3 presents variables by means of queries. For instance, for question “what is the symbol for the router 2?” a query is needed “symbolFor(router2, What)” where What is a variable. Students exercise variables by jotting down queries for related questions regarding other router. A novel relation hostOf(B, destination) is introduced to denote that the host of the destination.

Lesson 4 presents rules. It goes through knowledge describing destination and router: B is a host of destination which is then also a host of route. It therefore exhibits the rule for demonstrating it:

\[
\text{hostOf}(B, \text{destination}) :\neg \text{hostOf}(B, \text{route}).
\]

Students expand a known model by this rule and test it. The students therefore exercise by jotting down a rule for knowledge on reaching other destination and route and to test it.

Lesson 5 introduces more complex to the rules. It goes through field knowledge describing the destination and route. It is represented as

\[
\text{hostOf}(B, \text{destination}) :- \text{router}(r1, \text{route}), \\
\text{router}(r2, \text{route}), \text{hostOf}(B, \text{route}).
\]

where “,” between relations means conjunction.

3.2.2. Security Module. The 5-lessons module has a similar structure to the computer network one. Here the security problem included and its modelling information are given. The security theories covered are plaintext, ciphertext, uses encryption algorithm to create ciphertext from plaintext and uses decryption algorithm to create plaintext from ciphertext. Questions regarding the theories are raised, debated and clarified. In order to model the problem, the relations plaintext(X) (that is, X is a plaintext), ciphertext(X) (that is, X is a ciphertext), encrypt(X, Y) (the plaintext X is encrypted into the ciphertext Y), and decrypt(X, Y) (the ciphertext X is decrypted into the plaintext Y) have been introduced. The classical negation — also introduced in this module.

3.2.3. Execution. Every class meeting consists of one or numerous series. Every series consists of two- mechanisms concepts understanding (by lecturing and discussion with a period of 5-10 minutes) and programming exercises. Slides are downloaded to ease the lecturing and discussion.

3.3. Research Design
This lesson spans over for two weeks of 5 1 hour and 50-minutes long periods in the year 2020. Because of the exploratory environment of this study, topics that the contributing students had well-read have been selected. The aim is to assess students’ learning outcomes in network and security content and computation thought.

3.4. Data Gathering and Analysis
Pre- and post-surveys were administered to inspect the learning outcomes which have multiple-choice questions measuring students’ network and security context knowledge of interest and computer science skills. The computer network and security questions have been previously validated. Every question is ranked as either 1 (correct) or 0 (incorrect). The entire mark is the total of marks as of the entire questions. The questions as of the pre- and post-surveys are similar.

Here are a few questions for computer security. Pre- and post question. The initial message from Alia to Bakar is named plaintext; the message that is transmitted through the channel is named the ciphertext. In reference to the message, did Bakar use the decryption algorithm? A. Yes, B. No, C. Not certain, additional information is required. Here is a question for assessing abstraction in Computing. It is known that hostOf(B, destination) means that B is a host of destination, hostOf(B, route), means that B is a host of route. Write a rule to represent the subsequent knowledge: B is a host of destination which is then also a host of route. A. B is a host of destination which is then also a host of route B. hostOf(B, route) :- hostOf(B, destination). C. hostOf(B, destination) :- hostOf(B, route). D. None of the above.
One post group interview was also carried out for every year to measure the students’ response to the experience with the integration modules. The interviews were semi-structured. All 1st, 2nd and 3rd year students were recruited with a varied background in terms of gender, network and security matter knowledge and CT understanding (Table 1).

Table 1: The interviewees’ Background Information

|   | S3-1 | S3-2 | S2-1 | S2-2 | S2-3 | S2-4 | S2-5 | S2-6 | S2-7 | S2-8 | S2-9 | S1-1 | S1-2 | S1-3 |
|---|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Y | 3    | 3    | 2    | 2    | 2    | 2    | 2    | 2    | 2    | 2    | 2    | 1    | 1    |      |
| S | F    | M    | M    | M    | M    | M    | M    | M    | M    | M    | M    | M    | M    |      |
| NS| 3    | 4    | 1    | 2    | 3    | 1    | 2    | 2    | 1    | 2    | 2    | 2    | 2    | 4    |
| CT| 3    | 4    | 2    | 3    | 2    | 2    | 3    | 3    | 3    | 3    | 3    | 3    | 2    | 4    |

Y: year; S: sex; F: Female; M: Male; NS/CT: Network Security/CT mark out of 4. S3-i, S2-i, S1-i: code for students;

The interviews were audio-recorded and transcribe afterwards. Codes were built to identify students’ response to the incorporate modules. The interviewees’ comments were coded from three perspectives: module being attractive, computing being impactful to network and security learning, and network and security are being impactful to computing learning. For every type, an interviewee’s answer were coded as “Yes” (that is, permitting that statement), “No” (declining that statement), and “N/A” (that is, not stating it in the interview).

4. Results

4.1. Q1. How did the incorporation modules influence the students’ learning?

As of the interviews, students demonstrate positive experience with programming and LP. For instance, “logic programming is not easy to understand. But when you do, it is just a simplified English word. Comparing with other programming (C++, Java), logic programming are more simple” by S2-8. “It's pretty much enjoying to learn AI with logic programming because if you obtain the answer like hard work paid off” by S2-7. The favourite part of the class is “the coding part” by S2-3 (and approved by S2-1, S3-2, S2-6, S2-8 and S2-7). “My favourite part when to solve problem coding cause I need to think for it” by S3-2. When contrasting other programming paradigms for instance drag and drop, “It's not an easy things for but it still make me excited to always learn more” by S2-1.

Debugging is a vital part of programming. Students look like to be capable of carry out debugging and be grateful for its importance. Here are example quote. “When the program show some errors, we have to always double check the program in case we miss something about it” by S2-1. “Much like C++, the swi prolog application has this error indicator on what line and what error syntax that I used wrong, so I am quite familiar with it and so I thank for the developer of the swi-prolog to include this as well” by S1-1. When enquired if attempted to locate errors when program does not respond a query rightly, S2-3, S1-1, S2-1, S3-2, S2-6, S2-8, S2-9, and S2-7 answered yes while S3-1, S2-5, and S2-2 no. For CT practice communication, in the teaching, constantly begin as of English description of knowledge after that jot down rule(s) to denote the knowledge. Consequently, majority of students constantly jot down English description ahead of jotting down any rules. While commenting about this method “It helps how the program read it. Also you can verify if that is the outcome you want or not. So, it is useful” by S2-8.

4.2. Q2. How the partakers mirror on experience with the LP based incorporation?

The majority of the interviewees commented positively on experience with the incorporated modules. 9 out of 13 interviewees believed that modules were attractive (S2-2 and S2-6 was coded as “No” and S2-4 and S1-2 as “N/A”). 10 out of 13 interviewees believed that computing impacted network and
security learning (S2-6 is coded as “No”). Hence, the LP based incorporation of network and security and CT is recognized by students. “It is a plus addition to the network based computer field, as it gives more open world to the network technicians not just configuring LAN Networks all day but to more coding system” by S1-1. When talking about modelling network and security problems, “modelling computer network and security made us feel more expert because of undertaking something that is really experts would do” by S2-7.

5. Conclusion

LP based framework to incorporate computing and computer network and security teaching in University College has been proposed. In order to test its viability, two integration modules for 1st, 2nd and 3rd year have been developed. By experience, the framework permits a quite clear-cut modules development (visit Section 3.2). The modules development for other topics in computer network and security, based on the modules, will also be clear-cut. The analysis data demonstrate that students’ learning has been enhanced on computer network and security and CT (abstraction) considerably. Class observations and interviews prove that students are thriving in the facet of CT: communication and programming. Interviws as well demonstrate the LP based incorporation is recognized by students: the modules are attractive and there is a positive influence of computing and network security to each other.

In summary, LP based incorporation appears to be assuring in terms of the development and execution of the two 5-sessions modules, the students’ learning outcomes.

There are a few restrictions in this initial research. 1) It is difficult to test students’ development of problem solving ability, a CT exercise, for the reason that the quick period of the project. 2) Other variables are not controlled. For instance, the students’ retrieve to source of both network and security and computational science are not controlled.

References

[1] Chu W. (2019) Application of Data Encryption Technology in Computer Network Security. Journal of Physics: Conference Series, 1237(2), 1-5. doi:10.1088/1742-6596/1237/2/022049

[2] Calimeri F., Faber W., Gebser M., Ianni G., Kaminski R., Krennwallner T., Leone N., Maratea M., Ricca F., Schaub T. (2019) ASP-Core-2 Input Language Format. Theory and Practice of Logic Programming, 20(2), 294-309. doi:10.1017/S1471068419000450

[3] Malaysia Qualifications Agency (2015) Programme Standards: Computing https://www2.mqa.gov.my/qad/garispanduan/Computing.pdf

[4] Burnashev R.A., Gubajdullin A.V., Enikeev A.I. (2018) Specialized Case Tools for the Development of Expert Systems. In: Rocha A. Adeli H., Reis L.P., Costanzo S. (eds) Trends and Advances in Information Systems and Tecnologies. WorldCIST’18 2018. Advances in Intelligent Systems and Computing, vol 745. Spinger, Cham. https://doi.org/10.1007/978-3-31977703-0_59

[5] Qian K., Shi Y., Tao L. and Qian Y. (2017) Hands-On Learning for Computer Network and Security with Mobile Devices, 26th International Conference on Computer Communication and Networks (ICCCN), Vancouver, 1-6, doi: 10.1109/ICCCN.2017.8038526

[6] University College TATI (2020) Academic Guidelines Session 2020/2021 103.

[7] Ary D., Jacobs L.C., Irvine C.K.S., Walker D.A. (2019) Introduction to Research. 10th Edition. Cengage Learning.