Exploitation plan for

problem-based learning laboratory

Hanoi University of Science and Technology

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Content

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1. Name of the lab

HUST has built a modern active learning lab named AI and Cyber Security Active Learning Lab. The lab's infrastructure is an investment by HUST. The equipments in the lab has been purchased through the ALIEN project.

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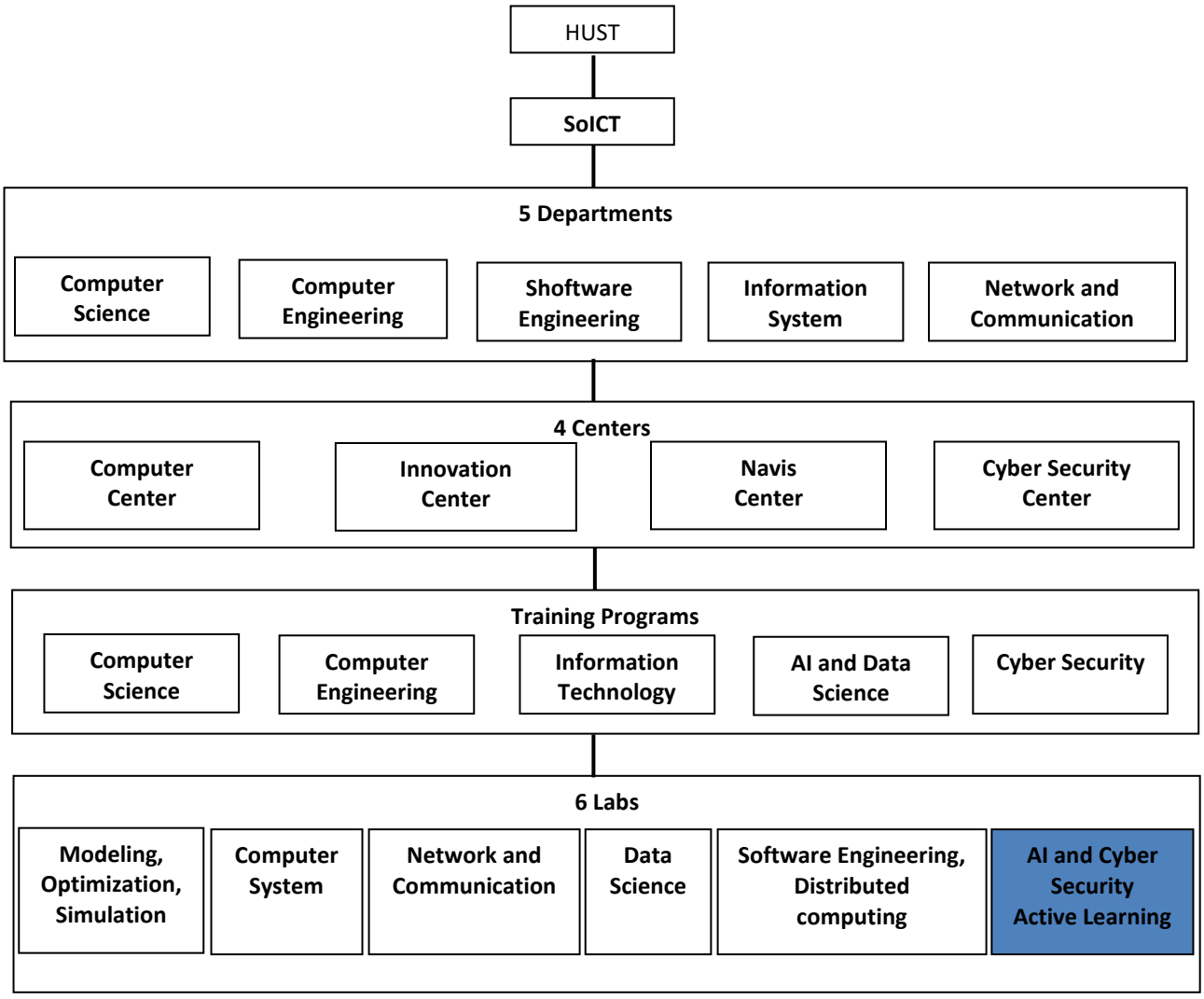
2. Faculty in which the lab belongs

The AI and Cyber Security Active Learning Lab belongs to the School of Information and Communication Technology (SoICT), Hanoi University of Science and Technology (HUST).

The organogram of SoICT is as follows:



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3. Purpose of the lab

The purpose of the AI and Cyber Security Active Learning Lab is to provide a modern practical training environment, applying active learning methods. The lab is designed as an open and flexible space so that instructors can easily organize teaching and learning in groups, suitable for active learning. The lab is equipped with modern equipment such as a computer for each student, TVs, projectors, screens, whiteboards, an audio system, and more. The lab is used to organize practice classes for advanced SoiCT training programs such as AI and Data Science and Cyber Security and to deliver short-term training courses on digital transformation, AI, information security, and more to staff in companies or other organizations.

3.1 Guidelines for use

3.1.1. Instructions for the use of the lab

- Purpose of the lab:
    - The lab is used for practical activities in courses of advanced training programs such as Cyber Security, Data Science and AI, and Global ICT. The practical courses of these programs will be permanently scheduled to take place in the lab.
    - The lab is further used to deliver short-term training programs to employees in companies and organizations. In 2020, SoICT organized a number of short-term courses on Cyber Security, AI, Data Science, Digital Transformation.
    - Finally, the lab is used to organize events and competitions for students.
- Registration for the use:

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- Lecturers of courses that have been permanently scheduled to take place in the lab do not need to register for the use of the lab.
- Lecturers who want to use the lab for unscheduled subjects, or use the beyond regular instruction hours, such as in evenings and weekends, or use the lab for other purposes such as organizing events or competitions for students, need to register on SoICT's website: https://qldt.hust.edu.vn/ .

- Technical support:
  - The lab is designed in a flexible manner. It offers approximately 40 seats for students, divided into 6 round table areas. Trainers who want to change the layout of the lab space, or want to add more seats, contact technical support.
  - The lab is equipped with computers, TVs, projectors, screens, whiteboards, sound systems, and WiFi. The computers run on Windows, Ubuntu, and Mac OS operating systems. They are further equipped with basic compilers such as for the C and Java programming languages. Teachers who need to add practice equipment or install additional software needed in their subjects, contact technical support.

3.1.2. Lab equipment

Hardware

- Computers: Aimed to be used by students for implementing practical projects during lab time.
- TVs: Used for group discussion or presentation.
- Projectors and screens: Used for instructor or student presentations.

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- Audio system: Used for instructor or student presentations.

Software

The lab computers run Windows, Ubuntu, and Mac OS operating systems. They are further equipped with basic compilers such as for the C and Java programming languages. However, teachers may ask technical support to install additional software for the support of their courses, if necessary.

3.2 Activities and courses

3.2.1. Courses that have been organized in the AI and Cyber security Active Learning lab

1. **Introduction to programming (using Python).**

   Engineering curriculum where it belongs: AI and Data Science.

   Course objectives: This course introduces students to the basics of programming including: i) basic concepts of programming such as variable, expressions, statements, control flow, and function; ii) basic data types and structures such as strings, lists, files, and classes; iii) basic concepts of exceptions, testing, and debugging. All algorithms and programming principles in the course are illustrated in Python. This course helps students feel justifiably confident of their ability to write small programs that allow them to accomplish useful goals.

   Number of students engaged: 50.

   Equipment, software, and educational material used:

   Equipment: Computers, TVs, projectors, audio systems.

   Software: Windows/Ubuntu, Python.

   Educational material:

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- Books:
    1. Peter Wentworth, Jeffrey Elkner, Allen B. Downey and Chris Meyers (2012). How to Think Like a Computer Scientist. Green Tea Press.
    2. John V. Guttag (2013). Introduction to Computation and Programming Using Python. MIT Press.
- Slides: provided by the lecturer.

Problem-based learning activities integrated in the course:

Course work includes exercises and assignments. Simple assignments are implemented individually by each student. Practical work takes place in the lab. The instructor introduces to the class a list of assignments, from which the students select one on which they work on in groups. Students design an algorithmic solution, and develop a program under the guidance of the teaching assistant. At the end of the course, the groups present their results to the class.

2. **Data Structures and Algorithms.**

Engineering curriculum where it belongs: Computer science.

Course objectives:

The course provides fundamental knowledge on the principles, computational features, and complexity of basic algorithms and data structures as the basis for developing information processing systems. Students learn how to build information processing systems through the development of simple application programs. The data structure section of the course focuses on arrays, lists, stacks, queues, some tree structures, and graphs. The algorithm section focuses on recursive algorithms, sorting algorithms, search algorithms, and graph algorithms.

Number of students engaged: 40.

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Equipment, software, and educational material used:

Equipment: Computers, TVs, projectors, audio systems.

Software: Windows/Ubuntu, C/C++/Java.

Educational material:

- Book:
  1. Data Structures and Algorithms in C++. 2nd Edition. Prentice Hall, 2000.
  2. Nguyễn Đức Nghĩa. Cấu trúc dữ liệu và thuật toán. NXB Đại học Bách khoa Hà nội, 2013. 368 trang.
- Slides: provided by the lecturer.

Problem-based learning activities integrated in the course:

Students implement and use basic data structures such as stacks, queues, priority queues, lists, trees, and hash tables. Students must be able to design and implement programs that use data structures to develop information processing systems. Students understand and implement basic searching and sorting algorithms such as quick sort, heap sort, merge sort, and hash tables. Students master basic algorithm building techniques such as recursion and division. Students analyze complexity in asymptotic notation language for basic algorithms and data structures. Problem solving is a key part of the course.

The instructor delivers lectures on theoretical aspects. Students follow the lectures and participate in practical lab work. Lab exercises are implemented in the C programming language. Teaching assistants guide students during lab practice following the theoretical teaching schedule of lecturers.

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Students are assigned a project to work in groups with an implementation time of about 2-3 weeks. Each project includes a number of in-depth math problems in class. This may involve a few difficult problems that require significant effort to solve. The implementation of these exercises is the best preparation of students for the exams.

The key to success is practice. The lecturer reviews data structures and algorithms implemented in the C programming language. Students learn how to apply theoretical solutions to real problems. In a first step, students are exposed to structures through theoretical lectures, followed by practical experiments and tutorials. For example, a lecturer teaches sorting algorithms and then the teaching assistant guides students through the practical implementation of algorithms in programs. Finally, students write a report in which they compare the efficiency of sorting algorithms on real datasets.

3. **Technical Writing and Presentations.**

Engineering curriculum where it belongs: All training programs of SoICT.

Course objectives:

The course aims to provide students with the understanding of principles and the development of practical skills on writing scientific and technical documents and delivering effective presentations. Students are introduced to the entire writing process including planning, drafting, evaluation, and editing. Students further analyze the objectives of the text, the organization of information, and the use of graphical support tools. Upon completion of the course, students are able to effectively write technical reports, theses, abstracts, proposals, CVs, and more in a correct and professional way. In addition, effective presentation techniques such as using voice, changes of tone, and body language are also introduced in this course. Students work in groups to formulate

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ideas and prepare the necessary material for writing and presenting, thereby building teamwork skills and positive collaboration attitudes.

Number of students to be engaged: 60.

Equipment, software, and educational material used:

Equipment: Computers, TVs, projectors, audio systems.

Software: Windows/Ubuntu.

Educational material:

- Books:
  1. Justin Zobel (2014), Writing for Computer Science, Springer.
  2. Lucinda Becker and Joan Van Emden (2016), Presentation skills for students, Palgrave.
- Slides: provided by lecturer

Problem-based learning activities that will be integrated in the course:

The content of the course consists of 2 parts, namely presentation and writing. Each part lasts 7 weeks. In each part, students choose a topic from a list of topics provided by the teacher, for example: Computer Graphics, Data Base & DBMS, Security, Computer Ethics, AI, IOT, the Fourth Industrial Innovation, Data Science, and Digital Transformation. Students research, explore content, and prepare slides. After this initial phase, the class is divided into small groups of 5 – 7 students. Each student presents his results to his group and receives comments and feedback from all group members.

During the course, students are assisted by teachers and teaching assistants.

3.2.2. List of courses that will use the AI and Cyber security Active Learning lab in the future

1. **Parallel and Distributed Programming.**

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This course introduces parallel and distributed programming and their applications towards solving high-performance problems on parallel or distributed computing platforms. The course consists of following topics: parallel and distributed computational architectures such as multi-threaded architecture, multi-core computational architecture, and general purpose GPUs; how to design parallel algorithms for high-performance problems; parallel programming models such as OpenMP, MPI, CUDA; developing parallel programs for several typical problems such as matrix computations, graphs, sorting, partial differential equations, and more. Upon completion of the course, students are able to develop algorithms themselves and write parallel programs using different parallel programming models with applications in several practical high-performance problems.

2. **Technical Writing and Presentations.**

   Please see description above.

3. **Scientific Computing.**

   The course helps students grasp the basic concepts of scientific computing and to understand common problems in science and engineering. It focuses on methods and algorithms for solving complex problems in science and engineering. The course also helps students become familiar with the use of programming languages for developing software towards solving complex problems in science and engineering.

   The course includes topics such as calculating and programming using MATLAB, problem errors and conditions, algebraic and calculus numerical methods, solving systems of linear equations, solving nonlinear equations, derivatives and integrals approximation, numerical methods for differential equations, curve fitting, numerical methods for

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optimization, non-linear programming, linear programming, and MATLAB application in scientific computing.

4. **Discrete Mathematics.**

The course is an introduction to discrete mathematics concepts of objects and their relationships. It introduces students to basic concepts of mathematical structures that are fundamentally discrete, rather than continuous. Concepts and notations from discrete mathematics are extremely useful in studying and describing objects and formulating problems in branches of computer science, such as computer algorithms, programming languages, cryptography, automated theorem proving, software development, and many other IT principles. The objects studied in discrete mathematics are various, such as logic, sets, functions, number theory, induction, combinations and permutations, graphs, recurrence relations, theoretical principles of cryptography, and trees. The course is mostly theoretical and takes place in an amphitheater. However, it is one of the key courses that highly important in building problem-solving capability, critical and analytical thinking. The curriculum is designed to build fundamental knowledge that is of use in other courses in the curriculum.

5. **Object-Oriented Programming.**

The course focuses on Object-Oriented Programming (OOP), a programming paradigm based on the concept of objects. OOP is a core development approach that is widely accepted around the world. Many of the most widely used programming languages such as C++, Java, Python, and more, are multi-paradigm and support object-oriented programming to a greater or lesser degree. The course aims to introduce students to the idea of programming with OOP, basic concept of objects and classes, the fundamental features of OOP, such as encapsulation, composition, inheritance, and delegation, and

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how to use OOP in software development. OOP offers benefits in re-usability, data redundancy, security, extensibility, easy troubleshooting and maintaining, and more. Concepts and schemes of OOP can be applied to improve programming and designing skills, which is highly important in almost every field of IT in general, especially software engineering. The course furthermore focuses on transversal skills including analytical thinking, critical thinking, entrepreneurial thinking, problem solving, planning and designing, ability to work in a team, and more.

6. **Network Management.**

Network management remains the least understood aspect of networking. Managers of today's enterprise and carrier networks face great challenges as they need to manage a variety of devices, protocols, and mechanisms to meet a diverse set of goals in performance, security, availability, and cost. The course provides students with a comprehensive view of the network management problem, including its concepts, scope, challenges, techniques, and related tools. Concepts are demonstrated in concrete applications and scenarios such as MPLS, VPN, VLAN, and more. The course furthermore focuses on how practical network management can contribute, in combination with pedagogical models, towards the development of basic, transversal skills including analytical thinking, critical thinking, entrepreneurial thinking, problem solving, ability to work in a team, and more.

7. **Database Management Systems.**

The course introduces the management of database systems. It emphasizes the understanding of the fundamentals of relational systems including data models, database architectures, and database manipulations. The course also provides an

understanding of new developments and trends such as internet database environment and data warehousing. The course deploys a problem-based approach to learning.

8. **Data Structures and Algorithms.**

   See description above.

9. **Fundamentals of Optimization.**

   Optimization problems are evident in many aspects of daily-life: resource planning, machine design, automation, business administration, finance, transportation, manufacturing, urban architecture, and more. This course provides students theoretical foundations of linear programming, integer programming, a number of exact algorithms, and heuristic methods. The students build skills that help them understand and model different optimization problems under mathematical formulations. During the course, the students are exposed to optimization software and programming libraries used to model and solve practical optimization problems.

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4. Resources

4.1 Equipment

The following equipment is available in the AI and Cyber Security Active Learning Lab. The equipment has been purchased through the ALIEN project.

Equipment	Detail Description	Quantity	Purpose
iOS Programming Computer Set	Laptop Apple Macbook Pro MPXQ2 128Gb (2018) Core i5 / Ram 8GB/ 128 SSD/ 13,3"/ Mac OSX with UGREEN 9-1 HUB	4	For use by student groups during class sessions
Android and Windows Programming Computer Set	Laptop Dell Inspiron 3476 (2018) CPUIntel® Core™ i7 8550U (1.80GHz Upto 4.00GHz, 4 cores 8 threads, 8MB Cache)	2	For use by student groups during class sessions
SmartTV	Smart TV 4K 65 inch, 4K Ultra HD	2	For group discussions and presentations. For simulations
Audio system	Sony BDVN9200W/BMSP1	1	For group discussions and presentations; for simulations

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Projector/Screen	Panasonic PT-LB383 Projector	1	For presentations to the entire class; instructors may use the equipment for introducing theoretical subjects or problems; student groups may use the equipment for presenting project results
Wifi Router	4G TP-Link M7350	1	For connecting the lab to the internet

In addition, the AI and Cyber Security Active Learning Lab is equipped with a number of computers sponsored by the Cyber Security project of Hanoi University of Science and Technology in cooperation with Korea. Through the above equipment the lab can accommodate groups of approximately 40 students.

4.2 Staffing

The management of devices in the lab and the registration process for using the lab takes place through the SoICT website, so there is no need for an administrator.

The lab is supported by a technician who is a permanent employee of SoICT. The technician will assist the lecturers in installing computers, setting up the working environment, and repairing and maintaining the equipments and software.

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The lecturers using the lab are permanent employees of SoICT. The number of lecturers depends on the number of courses held in the lab in each semester. In addition, courses are supported by teaching assistants. Usually each course is supported by 1 or 2 teaching assistants. The teaching assistants are Master's or PhD students at SoICT. Each teaching assistant receives an allowance through the regular budget of SoICT.

4.3 Financial support

After the completion of the ALIEN project the AI and Cyber Security Active Learning Lab will be managed and operated by SoICT. The cost of operating the lab includes salary for the employees who operate the lab, operating costs, in particular electricity fees, and maintenance fees for the repair and replacement of aging equipment in the lab.

SoICT is a unit of Hanoi University of Science and Technology. Each year, SoICT is allocated a budget of approximately 3m USD, which includes staff salaries, facilities costs, and other expenses. The employees who operate the lab are all staff members of SoICT, so they receive their salary from the central budget. Costs for operation, maintenance, repair, and replacement of equipment in the lab will be covered by the facilities budget of SoICT. In addition, SoICT often receives funding from external companies and organizations for equipment packages. These funds can use it to upgrade, replace, or supplement lab equipment.

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