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Building Skills 4.0 through University and Enterprise Collaboration

SHYFTE 4.0

WP2: Implementation of Shyfte framework for training and learning

D2.2: Pilot in domain 2

Software Engineering and Big Data Analytics vs:2.0

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The objectives of this deliverable are to describe:
- the learning materials
- the Training of trainers (ToT)
- the evaluation of the quality of the learning material and training
- the Training of students (ToS)
- the mitigation actions due to Covid 19.

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Further Information

http://www.shyfte.eu/

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Project Partners:

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1. Executive Summary

This document describes the implementation of the pilot project in China to significantly improve the quality of “Software Engineering and Big Data Analysis” courses through the use of the new skills required by the companies for the industry of the future. Based on the skills 4.0 framework and the teaching and learning materials defined in the WP2, the objectives of this deliverable are to describe:
- the learning materials
- the training of trainers sessions
- the evaluation of the quality of the learning material and training
- the training of students

Industry 4.0 is originally a future vision described in the high-tech strategy of the German government that is conceived upon the information and communication technologies in terms of **Cyber-Physical Systems, Internet of Things, Physical Internet and Internet of Services** to achieve a high degree of flexibility in production, higher productivity rates through real-time monitoring and diagnosis, and a lower wastage rate of material in production.

It is very important that the tasks in the preparation for Industry 4.0 is the adaption of the higher education to the requirements of this vision. The domains in the EU project that are defined in terms of **Industrial Engineering and Management, Software Engineer and Big Data Analytics, Wireless networks analytics, and Artificial Intelligence.**

In this project, CUIT and CDU focus on Domain 2 **Software Engineer and Big Data Analytics**. In CUIT and CDU, we adopt the method of systematic analysis, which considers teaching, learning, and enterprise requirements of student skills as a system that is harmonious. And the three elements are also coordinate and consolidate with each other. The relationships between the three elements are reflected in Fig.1. The skills gap among enterprise, teaching, and learning are measured by using the Bloom’s taxonomy model. The aims of judging the skills gap among these three elements are listed: **1). Improving learning outcomes; 2). Support learning and teaching, and 3). Deploying widely the effective teaching methods and efficient learning methods.**

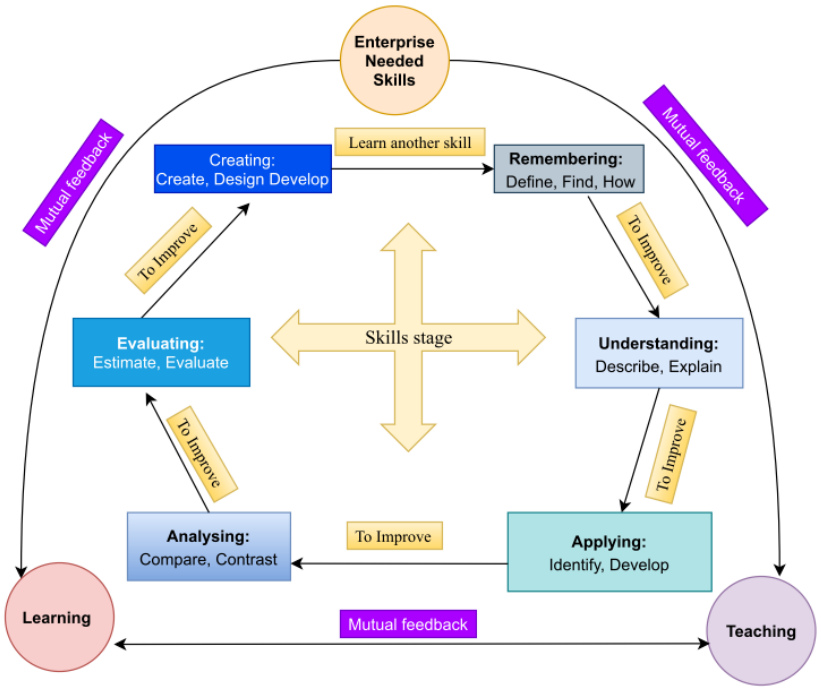


Fig.1. The Relationships Among Learning, Teaching, And Enterprise with Respect to Bloom's taxonomy model Under Industry 4.0

The training situation are described as follows:

After developing and revising the learning materials, the Training of the Trainers (ToT) sessions are conducted. In view of the COVID situation, ToT is divided into online and offline parts.

Part 1 of the ToT for domain 2 was held virtually for a total of 90 hours during June and December 2021. This part contains three modules: 1). Principle and Application of BigData Technology; 2). Critical Thinking Oriented BigData; 3). Data Mining Ideology and Technology. Part 2 of the ToT for domain 2 has been conducted by offline teaching. This part contains two modules: 1). Comprehensive Training of Artificial Intelligence; 2). Smart Decision Making with BigData. For both modules, we firstly recorded the classes and then uploaded the resources online. Not only that, part 2 involves more hands-on with the usage of purchased equipment and software. It had a live demonstration of the equipment handling. And we also use the purchased equipment to record students' classroom expressions data and analyze students' learning situation. The total number of trained teachers exceeds 60.

Following the ToT, we distributed questionnaires to all participants to get feedback on quality of the ToT. Based on the collected responses, the audience generally satisfied with the ToT. In part 1, compared with the other two courses, the least participants were interested in the "Critical Thinking Oriented BigData" module. There is also a more prominent problem, some participants can not understand the content of the module. In view of the above problems, trainer(s) should providing more suitable learning materials. Compare to part 1, the audience are much more

satisfied with the part 2, So we should have more face-to-face communication to improve the quality of the ToT.

The Shyfte 4.0 Training of Students (ToS) for Pilot 2 Software Engineering and Big Data Analysis have been conducted from 14 March to 20 June 2022. Chengdu University of Information Engineering(CUIT) and Chengdu University(CDU) have conducted different forms of ToS respectively. The participants are first year postgraduate students from Software Engineering, Electronic Information and Agricultural Engineering and Information Technology.

Part 1 of the ToS is held in the learning education center of CUIT. This part contains three modules: 1). Principle and Application of BigData Technology; 2). Comprehensive Training of Artificial Intelligence; 3). Smart Decision Making with BigData. As for the module "Comprehensive Training of Artificial Intelligence", which is an important discipline to teach the professional knowledge of artificial intelligence and the related machine learning topic. The module "Smart Decision Making with BigData" mainly introduces common data analysis knowledge and skills as well as intelligent decision-making based on data analysis. The module "Principle and Application of BigData Technology" introduces the principal technology of BigData. CUIT trained 188 students in part 1. Part 2 of the ToS is held by CDU. It has done the course of "Critical Thinking Oriented BigData" and "Data Mining Ideology and Technology" online. The module "Critical Thinking Oriented BigData" will make students build up consciousness of critical thinking. Overall, the TOS have been trained over 200 students of five modules.

After the training, CUIT and CDU received the positive feedback, more than 90 percent respondents were interested with the content of the modules. Satisfaction with 17 questions was also above 90 percent. Judging from the student feedback, we should encourage the students to communicate with their teachers in time. At the same time, teachers should also teach in a more specific and appropriate language.

Next, we will illustrate the KPIS that have been finished by CUIT and CDU.

T2.2	Pilot in domain2 - Software Engineering and big data analysis	The T2.2 Task describes the implementation of a second pilot project in China to improve the "Software Engineering and big data analysis" skills.		
T2.2- 0	Learning Material development	Skill set and modules developed: theoretical part, industrial use cases, learning method, data sets and equipment used…	- at least 6 Modules are developed for SE & bigdata analysis	- 5 modules are developed for SE & bigdata analysis
T2.2- 1	Validation by the group of expert	The module validation process (by the Advisory Board and Academic experts)	- 6 modules reviewed by Internal and External experts	- 5modules reviewed by Internal and External experts

T2.2- 2	Training of the trainer's sessions	The training of the trainers sessions will be held in October in China. If the COVID situation don't let the EU partners to travel, we will participate remotely.	- 15 to 20 trainers trained from CDU and from CUIT - 1 staff per partner trained - 5 quality evaluation questionnaire filled per module	- 30 trainers trained from CDU and from CUIT - at least 1 staff per partner trained - 6 quality evaluation questionnaire filled per module
T2.2- 3	Learning materials assessment & update	Analysis of the quality questionnaire and assessment of the learning materials	- Analysis of the training quality questionnaire - 1 improvement plan per module is defined - All the modules are updated	- Having analysis of the training quality questionnaire - at least 1 improvement plan per module is defined - All the modules are waiting to be updated
T2.2- 4	Student's maturity level assessment	Evaluation of the skills maturity students' level	- The maturity level is defined for each category of students	- The maturity level is defined for each module
T2.2- 5	Training of the student's sessions	Training of the students in CDU and CUIT	- 100 to 120 students trained from CDU and from CUIT - at least 70% of the students fill the quality evaluation questionnaire - 80% of the students are globally satisfied	- 144 students trained from CDU and from CUIT - at least 92% of the students fill the quality evaluation questionnaire - 92% of the students are globally satisfied
T2.2- 6	Learning materials assessment & update	Analysis of the quality questionnaire and assessment of the learning materials	- Analysis of the training quality questionnaire - 1 improvement plan per module is defined - All the modules are updated	- Having analysis of the training quality questionnaire - at least 1 improvement plan per module is defined - All the modules are

				waiting to be updated
T2.2- 7	Training of Companies	Organize training for companies and evaluate the interest and quality of the training.	- 5 to 10 persons from one or different companies trained - A quality evaluation questionnaire is filled - Analysis of the quality questionnaire is done	- 5 persons from private companies trained

2. Domain 2: Software Engineering and Big Data Analysis

Through the summary and analysis of the recruitment information of some Chinese enterprises, it can be considered that under the background of industry 4.0, enterprises currently have a huge demand for talents in big data, cloud computing, artificial intelligence and other related fields. They hope to use this knowledge to help them improve their existing understanding and obtain more markets. Therefore, in domain 2, we set some topics to solve the problems faced by enterprises at present.

The learning framework for the second domain “Software Engineering and Big Data Analysis” include four skill sets (SkS) which are defined in Figure 1.

2.1 Domain 2: Skill Sets

The “Software Engineering and Big Data Analysis” domain is composed of four skillsets:
SkS-D2-1: BigData Science Analysis
SkS-D2-2: BigData System Management
SkS-D2-3: Cloud Computing System
SkS-D2-4: AI for BigData Analysis

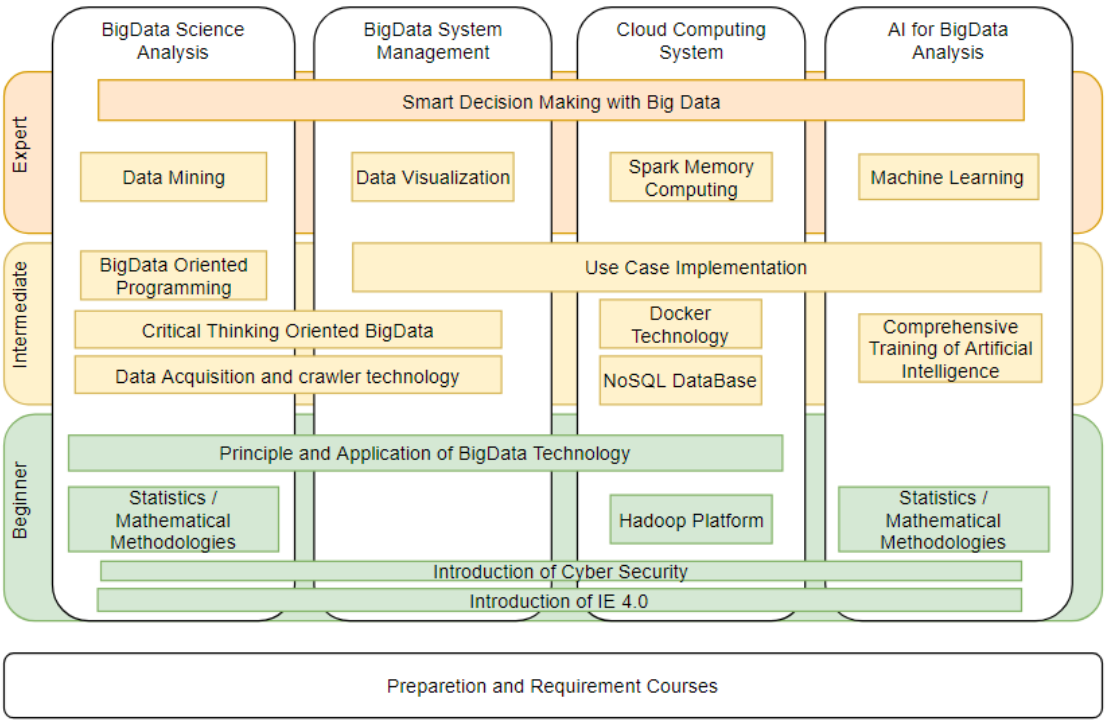


Figure 1: Learning Framework – Domain 2: Software Engineering and Big Data Analysis

2.2 Domain 2: Learning materials Overview

The purpose of this document “Shyfte 4.0”, is to identify the use of the new skills required by the companies for the industry of the future. In domain 2, there are 18 modules included in this framework. Among these 18 modules, 14 modules are urgently needed by the industry. The 14 modules are as follow:

- Introduction of Cyber Security
- Principle and Application of BigData Technology
- Statistics/Mathematical Methodologies
- Data Acquisition and Crawler Technology
- Critical Thinking Oriented BigData
- BigData Oriented Programming
- Data Mining Ideology and Technology
- Smart Decision Making with BigData
- Data Visualization
- NoSQL DataBase
- Docker Technology
- Spark Memory Computing
- Comprehensive Training of Artificial Intelligence
- Machine Learning

In Figure 1, “Introduction to IR4.0” is included in all four domains and developed by partners of Domain one (CMU-KU). The above 14 modules are jointly developed by Chengdu University and Chengdu University of Information Technology to fulfil the skills requirement in WP2.

Learning materials of **5 new developed modules** are detailed in the next section.

3. Learning Materials Description

This section provides detailed information about the learning materials developed including the topics, teaching plans (delivery method and soft skills), prerequisites and learning outcomes.

3.1 Principle and Application of BigData Technology

MODULE TITLE	**Principle and Application of BigData Technology**			
TOTAL LEARNING HOURS	:	18 hours		
PRE-REQUISITE	:	Introduction to BigData		
LEARNING OUTCOMES	:	Participants will design a bigdata system by using HDFS, HBase, and MapReduce.		
SYNOPSIS	:	This module introduces the principal technology of BigData. By using an online experiment platform, students will grasp the knowledge of HDFS, HBase, MapReduce by a series of experiments on class. Students should have Java programming skill and familiar with Unix operating system before this module.		
MODULE CONTENTS				
				Learning Hours
TOPICS	:	1.	BigData Introduction	
			- Examples of BigData - Types of BigData - Characteristics of BigData - Key technologies of BigData - Benefits of BigData processing	1
		2.	Hadoop Fundamentals	1
			- Introduction of Hadoop - Hadoop features - Evolution of Hadoop - Ecosystem and components of Hadoop - Hadoop Architecture - Network topology in Hadoop	
		3.	HDFS Fundamentals	8
			- Distributed file system	

			- HDFS architecture - Terms of HDFS - Read Operation - Write Operation - Access HDFS using JAVA API - Access HDFS using COMMAND-LINE INTERFACE	
		4.	MapReduce Programming	8
			- Introduction of MapReduce - Basic operation principle of MapReduce - Access HDFS using COMMAND-LINE INTERFACE	
			Total	**18**
DELIVERY	:	Lecture		
METHOD		Case study		
		Experimental operation		
SOFT SKILLS	:	Basic theory of industry application Presentation skill Ability to implement projects		
REFERENCES	:	1. Elgamal T, Yabandeh M, Aboulnaga A, et al. sPCA: Scalable principal component analysis for big data on distributed platforms[C]//Proceedings of the 2015 ACM SIGMOD International Conference on Management of Data. 2015: 79-91. 2. Ghazi M R, Gangodkar D. Hadoop, MapReduce and HDFS: a developers perspective[J]. Procedia Computer Science, 2015, 48: 45-50. 3. Foley M. High availability HDFS[C]//28th IEEE Conference on Massive Data Storage, MSST. 2012, 12. 4. Goodrich M T, Sitchinava N, Zhang Q. Sorting, searching, and simulation in the mapreduce framework[C]//International Symposium on Algorithms and Computation. Springer, Berlin, Heidelberg, 2011: 374-383. 5. Dittrich J, Quiané-Ruiz J A. Efficient big data processing in Hadoop MapReduce[J]. Proceedings of the VLDB Endowment, 2012, 5(12): 2014-2015.	

3.2 Comprehensive Training of Artificial Intelligence

MODULE TITLE		Comprehensive Training of Artificial Intelligence		
TOTAL LEARNING HOURS	:	20 hours		
PRE-REQUISITE	:	Introduction to machine learning		
LEARNING OUTCOMES	:	Students are able to analyze complex issues related to Supervised learning, Unsupervised learning,Semi-supervised learning, data reduction, and recommendation problems		
SYNOPSIS	:	The module of "Comprehensive Training of Artificial intelligence" is a comprehensive frontier discipline, which is an important discipline to teach the professional knowledge of artificial intelligence and the related machine learning topic. On the basis of the fundamental ability of mathematics and programming, this module gives a comprehensive explanation of several branches of artificial intelligence in terms of supervised learning, unsupervised learning, semi-supervised learning, data dimensionality reduction, and recommended algorithms. By teaching artificial intelligence course, students can master the basic principles of artificial intelligence technology. It can also enhance students' logical thinking ability and experimental practice ability. Moreover, it is a key module for students to master the principles, methods and technologies for computer vision, deep learning and also other major research fields.		
MODULE CONTENTS				
				Learning Hours
TOPICS	:	1.	Basic terminology: supervised learning	4
			- Supervised learning - K-nearest neighbor classification - KNN Algorithm Summary - KNN in Python	
		2.	Basic terminology: unsupervised learning	4
			- Unsupervised learning - Clustering - The k-means algorithm - Time complexity analysis - K-means summary - K-means in Python	
		3.	Basic terminology: Semi-supervised learning	4
			- Semi-supervised learning - Co-training - Semi-Supervised (Transductive) SVM	

			- Graph-based methods - Standard formulation (PAC) for supervised learning - Label Propagation - Cluster Assumption vs. Maximum Margin	
		4.	Basic terminology: Dimensionality Reduction	4
			- Dimensionality reduction - Pricipal component analysis: PCA - Multidimensional scaling (MDS) - FastMap algorithm	
		5.	Basic terminology: Recommendation	4
			- Recommender systems - Paradigms of recommender systems - Collaborative Filtering (CF) - Summarizing recent methods - Recommender systems in e-commerce - Content-based recommendation - Term-frequency - Inverse document frequency (TF-IDF) - Knowledge-based recommender systems - Constraint-based recommendation - Hybridization Strategies - Summary of online consumer decision making	
			Total	**12**
DELIVERY	:	Lecture		
METHOD		Case study		
		Group work		
SOFT SKILLS	:	Problem solving Python programming Presentation skill		
REFERENCES	:	1. Cunningham P, Cord M, Delany S J. Supervised learning[M]//Machine learning techniques for multimedia. Springer, Berlin, Heidelberg, 2008: 21-49. 2. Ghahramani Z. Unsupervised learning[C]//Summer school on machine learning. Springer, Berlin, Heidelberg, 2003: 72-112. 3. Zhu X, Goldberg A B. Introduction to semi-supervised learning[J]. Synthesis lectures on artificial intelligence and machine learning, 2009, 3(1): 1-130. 4. Sorzano C O S, Vargas J, Montano A P. A survey of dimensionality reduction techniques[J]. arXiv preprint arXiv:1403.2877, 2014. 5. Lü L, Medo M, Yeung C H, et al. Recommender systems[J]. Physics reports, 2012, 519(1): 1-49.		

3.3 Critical Thinking Oriented BigData

MODULE TITLE		Critical Thinking Oriented BigData		
TOTAL LEARNING HOURS	:	12 hours		
PRE-REQUISITE	:	Introduction to critical thinking		
LEARNING OUTCOMES	:	Students will be able to critically analyze and evaluate data quality, making rational decisions.		
SYNOPSIS	:	Most current issues of big data focus on addressing the technical, managerial and social challenges, with little reference to critical thinking that could significantly aid to guarantee the quality of data and lead to rational decision-making. This module will make students build up consciousness of critical thinking and, through case studies and group-based activities, clearly understand the relationship of critical thinking and big data analytics, inspiring them to apply thinking skills to deal with the big data challenges.		
MODULE CONTENTS				
				Learning Hours
TOPICS	:	1.	Introduction of CTOB	1
			- Learning outcomes - The path of critical thinking - Being a critical thinker - Mind actions and critical thinking processes - Problem solving and decision making - Introduction of BigData - Critical thinking oriented BigData	
		2.	Problem solving	2
			- Activity fact and opinion - Activity question and assumption	
		3.	Data collection	2
			- Activity data preparation and pre-processing	
		4.	Data analysis	2
			- Activity data correlation analysis	
		5.	Data decision	2
			- Activity lean canvas and business model	
		6.	Project task	3

			- Activity swot analysis - Project-based task	
			Total	**12**
DELIVERY	:	Lecture		
METHOD		Case study		
		Group work		
SOFT SKILLS	:	Problem solving Critical thinking Teamwork		
REFERENCES	:	1. Song I Y, Zhu Y. Big data and data science: what should we teach?[J]. Expert Systems, 2016, 33(4): 364-373. 2. Ennis R H. A logical basis for measuring critical thinking skills[J]. Educational leadership, 1985, 43(2): 44-48. 3. Huda M, Anshari M, Almunawar M N, et al. Innovative teaching in higher education: The big data approach[J]. TOJET, 2016: 1210-1216. 4. Helbing D, Frey B S, Gigerenzer G, et al. Will democracy survive big data and artificial intelligence?[M]//Towards digital enlightenment. Springer, Cham, 2019: 73-98. 5. Power D J. 'Big data'decision making use cases[C]//International Conference on Decision Support System Technology. Springer, Cham, 2015: 1-9.		

3.4 Smart Decision Making with BigData

MODULE TITLE	**Smart Decision Making with BigData**	
TOTAL LEARNING HOURS	:	16 hours
PRE-REQUISITE	:	Introduction to BigData
LEARNING OUTCOMES	:	Students master common data analysis methods and data visualization methods, and can use a reasonable decision-making model to complete smart decision-making.
SYNOPSIS	:	This module mainly introduces common data analysis knowledge and skills as well as intelligent decision-making based on data analysis. Through the learning of this module, students can master the process of data analysis, commonly used data analysis methods, data visualization methods and main decision-making models, so as to lay a good foundation for data analysis of smart decision-making based on big data.
MODULE CONTENTS		

				Learning Hours
TOPICS	:	1.	Introduction of smart decision making	2
			- Background knowledge of smart decision making - Decision-making support system - Typical application of smart decision making	
		2.	Data processing	4
			- Introduce to BigData - Types of data - Data cleaning - Common processing methods	
		3.	Data modeling and analysis	4
			- Common modeling methods - Specific analysis methods of data	
		4.	Visual analysis	2
			- Data visualization solutions - Specific methods	
		5.	Case analysis	4
			- Smart decision case analysis	
			Total	**12**
DELIVERY	:	Lecture		
METHOD		Case study		
		Group work		
SOFT SKILLS	:	Problem solving Python programming Presentation skill		
REFERENCES	:	1. Li C, Chen Y, Shang Y. A review of industrial big data for decision making in intelligent manufacturing[J]. Engineering Science and Technology, an International Journal, 2021. 2. Duan Y, Edwards J S, Dwivedi Y K. Artificial intelligence for decision making in the era of Big Data–evolution, challenges and research agenda[J]. International journal of information management, 2019, 48: 63-71. 3. Tran Thi Hoang G, Dupont L, Camargo M. Application of decision-making methods in smart city projects: a systematic literature review[J]. Smart Cities, 2019, 2(3): 433-452. 4. Cambra Baseca C, Sendra S, Lloret J, et al. A smart decision system for digital farming[J]. Agronomy, 2019, 9(5): 216. 5. Rathee G, Garg S, Kaddoum G, et al. Decision-making model for securing IoT devices in smart industries[J]. IEEE Transactions on Industrial Informatics, 2020, 17(6): 4270-4278.		

3.5 Data Mining Ideology and Technology

MODULE TITLE		Data Mining Ideology and Technology		
TOTAL LEARNING HOURS	:	24 hours		
PRE-REQUISITE	:	Introduction to Data Mining		
LEARNING OUTCOMES	:	Students are able to master the key technologies of data mining, explore the relationship and values of massive data. In addition, the idealogy of different classic algorithms should be learned.		
SYNOPSIS	:	This module introduces the ideologies and key technologies of Data Mining. By introduction of theoretical knowledge and the demonstration of classic algorithms, the related technologies of Data Mining will be demonstrated clearly. Three major parts are included in this module: the mining procedure and evaluation, objects association and fuzzy processing, supervised and unsupervised learning. Moreover, students are encouraged to conduct some related algorithms on python or matlab platform. Through systematic learning, students will master the ability of exploring the laws of data.		
MODULE CONTENTS				**Learning Hours**
TOPICS	:	1.	Introduction	1
			- The history of Data Mining – recent history - What is Data Mining - Relationship - Algorithms used in DataMining	
		2.	Finding similar items	2
			- What does the ‘similar items’ do ? - Applications of set similarity - Similarity of Documents - K-shingles - Computing minhash signatures in practice - Locality-Sensitive hashing for documents - Distance measures	
		3.	Frequent itemsets	2
			- The Market-Basket model - Association rules - Finding association rules with high confidence - Market baskets and the A-Priori algorithm - The A-Priori algorithm - The Machine-Learning model	
		4.	Classification	4
			- Introduction to different methods - Approaches to machine learning - Decision tree - Neural network	

			- High dimensional data	
		5.	Clustering	4
			- Introduction to different methods - Hierarchical clustering - k-means algorithm - The BFR algorithm - CURE algorithm	
		6.	Link analysis - Graph data - Page rank - Efficient computation of page rank - Link spam	4
		7.	Recommendation systems - Formal model - Key problems - Content-based recommendations - Collaborative filtering	4
		8.	Dimensionality reduction - Dimensionality reduction method - Principal component analysis	3
			Total	**24**
DELIVERY	:	Lecture		
METHOD		Case study		
		Group work		
SOFT SKILLS	:	Problem solving		
		Python programming		
		Presentation skill		
REFERENCES	:	1. Romero C, Ventura S. Data mining in education[J]. Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, 2013, 3(1): 12-27. 2. Gorade S M, Deo A, Purohit P. A study of some data mining classification techniques[J]. International Research J. of Engineering and Technology (IRJET), 2017, 4. 3. Bhatia T. Link analysis algorithms for web mining[J]. IJCST, 2011, 2(2): 43. 4. Vairavasundaram S, Varadharajan V, Vairavasundaram I, et al. Data mining-based tag recommendation system: an overview[J]. Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery, 2015, 5(3): 87-112. 5. Houari R, Bounceur A, Kechadi M T, et al. Dimensionality reduction in data mining: A Copula approach[J]. Expert Systems with Applications, 2016, 64: 247-260.		

4. Use of Shyfte Equipment

Regarding the use of Shyfte equipment, this part introduces equipment description, the whole process of using this equipment and the examples of use cases which are summarized as details below:

4.1 The equipment description

We have the equipment as details below：

1). Mobile Workstation RTX2060

2). EPTZ Application Software

3). Recording Host AE-E3SU

4). HD Camera Management Software

5). Directional Pickup Microphone AT-880

6). Graphics Workstation T7920

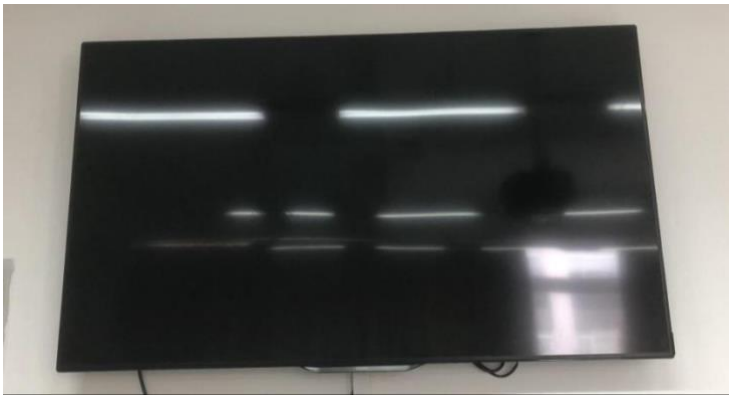
7). Digital Display Terminal Epson CB-2255U

8). Black and White Laser Output Terminal HP m227fdw

9). HD Camera AX-E16PT、AX-E16PS

10). Recording Panel KP-5A

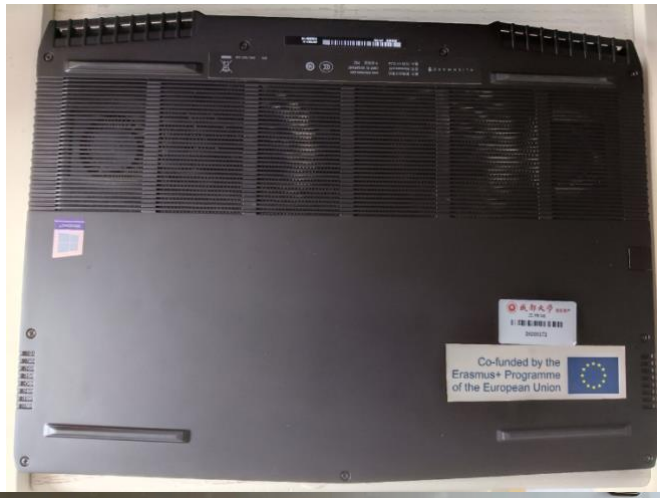
11). Digital Computer Workstation Alienware m15、Thinkpad Carbon 2019、Yoga C940、Thinkpad T490



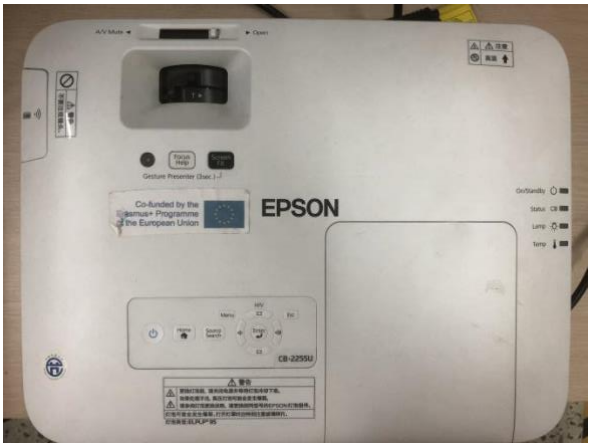
Digital Board

projector

EPTZ Application Software



Digital Computer Workstation



Projector, Printer and Directional Pickup Microphone

4.2 The description of the whole process of using equipment

1). Server: equipped with rtx2060 graphics card, mainly responsible for running the model required in the project

2). Automatic tracking camera: mainly used to collect relevant data such as students' faces in class

3). Projector: mainly used in meeting scenes to discuss project progress

4). Printer: used for printing project related documents

We arrange most of the software and hardware equipment in the "Learning Center" for teachers and students to use in the learning center. Teachers are responsible for the management of the software and hardware equipment. At the same time, we integrate most of the software in the server and use the software through the server. The rtx2060 graphics card also provides better services in data collection, processing, model operation and so on, the

purchased hardware also facilitates project seminars and project progress tracking. After use, pay attention to the maintenance of the equipment for subsequent use.

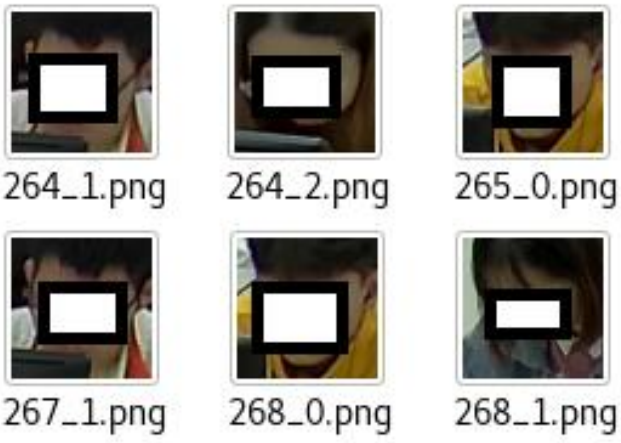
4.3 Examples of use cases

1). We collect the student information in class-:

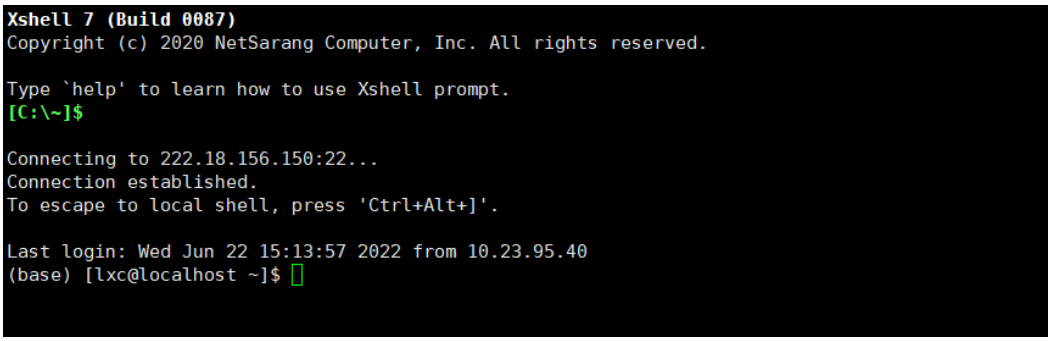
We use the equipment to capture the classroom teaching video into images. Because HD cameras have a frame rate of 30 frames, we take a face detection image every 30 frames.

We cropped the faces in the images and developed a face dataset in class.

The classifier is trained by face dataset and Google open-source face model.



Here is the method to Log in to the server interface :



We give a list of the classes that we have collected the face information:

course title	period	Video size	Number of d etected faces	Final number of images	the number of students
Algorithm analysis and application	1	1.2 GB	8983	6836	6
	2	1.8 GB	15084	10590	6
	3	1.8 GB	364	155	2
	4	1.8 GB	5227	4597	2
	5	1.8 GB	13868	4846	2
C language programming	1	1.8 GB	3339	3251	2
	2	1.8GB	3290	3248	2
objectoriented programming in JAVA	1	1.4 GB	6521	2698	3
Programming in Python	1	906.0 MB	4925	2966	5
	2	906.0 MB	5461	3280	5
	3	412.0 MB	2598	1499	5
engineering practice III	1	1.8 GB	14647	6818	3
	2	1.8 GB	12162	4966	2
average quantity			**7421**	**4288**	**3**

Curriculum System Table

curriculum	Equipment support	curriculum system
Advanced mathematics **linear algebra** **probability and statistics**	EPTZ Application Software Directional Pickup Microphone AT-880 Recording Host AE-E3SU Digital Display Terminal Epson CB-2255U	The curriculum system of basic theory is composed of professional knowledge

Multivariate statisticlanalysis **college physics** **fundamentals of electronic technology** **digital circuits and logical programming** **discrete mathematics**	Black and White Laser Output Terminal HP m227fdw HD Camera AX-E16PT、AX-E16PS Recording Panel KP-5A	of mathematics, natural science and engineering
An introduction to the engineering **Object-oriented programming (Java/C++)** **C language programming** **data structure**	Mobile Workstation RTX2060 Digital Computer Workstation Alienware m15 EPTZ Application Software Directional Pickup Microphone AT-880 Graphics Workstation T7920 Black and White Laser Output Terminal HP m227fdw Recording Panel KP-5A	Practical coding ability for specific functions to design models and build algorithms to solve
Database theory **Fundamentals of Disk Operating System** **Software Manufacturing - Engineering** **network of computer**	Mobile Workstation RTX2060 Digital Computer Workstation Alienware m15 EPTZ Application Software Recording Host AE-E3SU Directional Pickup Microphone AT-880 Graphics Workstation T7920 Black and White Laser Output Terminal HP m227fdw	Application system can use relevant knowledge and data model to deduce and analyze application problems in computer system, data management and transmission
Engineering Practice I (Coding Training) **Engineering Practice II (Software Technology)** **Engineering Practice IV (Integrated Training)**	Mobile Workstation RTX2060 Digital Computer Workstation Alienware m15 EPTZ Application Software Graphics Workstation T7920 Digital Display Terminal Epson CB-2255U Black and White Laser Output Terminal HP m227fdw Recording Panel KP-5A	Engineering systems are used for practical knowledge and mathematical models

4.4 The link of the equipment with the modules

This equipment are used in the Learning Education Center of the School of Software Engineering, Chengdu University of Information Engineering and College of Computer Science, Chengdu University. And they are mainly related to 2 curriculum systems. Curriculum system one is the training of students' practical coding skills and the design of model algorithms for solving specific problems at CUIT and CDU, which is related to 4 curriculum modules, including Introduction to Engineering, C Programming, JAVA Object-Oriented Programming, and Data Structures. Course system two for CUIT and CDU for students to apply the system can be related to knowledge and data models for computer systems, data management and transmission and other aspects of the

application of the problem of push to, analysis ability training. During the training period of the course system, HD cameras are used to film and record the classroom performance and learning status of the students in the Learning Education Center, to display the course documents and program code modules for the students in the digital display terminal, and to analyze and introduce the course using the pointing microphone. In the classroom, we use HD camera management software to extract face images from the videos captured during the course and analyze students' classroom concentration and learning status. The two courses offered by the Learning Education Center are mandatory courses for the training of software engineers at CUIT and CDU. The courses ensure that students can master and apply the basic programming language, and at the same time record and analyze the students' performance in the course so that the course can be improved and enriched.

5. Learning Materials Review

To ensure the quality of developed learning materials, all the newly developed modules have been reviewed and improved based on the feedback of internal and external reviewers. This section will highlight the overview of both the internal and external reviews. Details of the reviews have been filled in the reviewer form.

5.1 Principle and Application of BigData Technology

Module Contributors: Yu XI
Module Trainers: Yu XI
Skill Level: Beginner
Module Assessment: Assignment, Project presentation, Assessment rubric for teamwork
Course Arrangement: 18 hours
Evaluation Method: Quiz at the end + Questionnaire (learning material + Teaching method)

Internal Reviewer's Name	**Dr. Xiaodong Yu**
Position	**Lecturer**
Organization (University/Company)	**Chengdu University**
Date Review Completed	**2021/1/10**
Instructional Design Eléments Score	**46/60**
Content Score	**18/25**
Suggestions	More cases needed in the slides.

External Reviewer's Name	**Dr. Min Yao**
Position	**External : Principal 3D Engineer**
Organization (University/Company)	
Date Review Completed	**2020/11/6**
Instructional Design Eléments Score	**45/60**
Content Score	**18/25**
Suggestions	With the advent of the Fourth Industrial Revolution, the widely use of IoT devices and machines, Big Data is becoming the focus of many companies. Vision solution companies being an important part of industrial 4.0, Big Data engineers and experts are

	specially needed. It is also important that non Big Data engineers in the company also have basic data analysis mind, so that they can quickly identify the problem and make right requests to the BD specialists. Candidates who succeed this course shall obviously be competitive in the job market. The course material shows clear objective: to give student basics of Big Data, and to train the students the capability to identify and model real world Big Data problem problems. It starts with an overview of what is Big Data, why it is needed the Big Data processing, the characteristics of Big Data. The course then guides the students further understanding through hands-on practices with the tools generally used today by Big Data engineers. Students shall be guided the basics of using Hadoop with HDFS, MapReduce, Hive etc. At the end, the course also shares case studies, with the detailed analysis step by step the method to collect, store, organize data using Big Data solution. The course design structure shows very clear logic. It combines theoretical training with detailed experiment instructions corresponding to each chapter to enhance students' understanding. I believe students shall achieve good level of Big Data analysis at the end of this training.

5.2 Comprehensive Training of Artificial Intelligence

Module Contributors: Haiqing Zhang
Module Trainers: Haiqing Zhang
Skill Level: Intermediate
Module Assessment: Assignment, Project presentation, Assessment rubric for teamwork
Course Arrangement: 20 hours
Evaluation Method: Quiz at the end + Questionnaire (learning material + Teaching method)

Internal Reviewer's Name	**Dr. Qiang Pu**
Position	**Associate Professor**
Organization (University/Company)	**Chengdu University**
Date Review Completed	**2021/5/14**
Instructional Design Eléments Score	**47/60**
Content Score	**19/25**
Suggestions	No further comments.

External Reviewer's Name	**Dr. Xun Sun**
Position	**External Professor**
Organization (University/Company)	**School of Geographic Sciences, East China Normal University,China**
Date Review Completed	**2021/6/23**
Instructional Design Eléments Score	**45/60**
Content Score	**19/25**
Suggestions	This training course offers fundamental knowledge for big data analytics, aiming at training students to understand essential theory and practice application with experiments. The course is comprehensive, which contains five chapters. The first three chapters discuss supervised, unsupervised and semi-supervised learning, which are the basis for AI. The fourth chapter discusses dimension reduction, which is important for handling big data. The last chapter discusses a practical topic, focused on using AI technology to recommend useful products for clients. In general, the design of the course is appropriate, which can meet the teaching objectives. As the first theme of the series course "Software Engineering and Big data analysis", having relative more theoretical topics in this course is a very good idea. This will help students to get familiar with the ideas and theories, before starting more practical topics. In each chapter, theories are firstly introduced, then followed by examples and projects. This teaching method is thus suitable for the first theme of the series course. Maybe it would be better to have the course "Data mining" before this course, so that students can have a better understanding on data itself prior to working with AI technologies. In terms of the design of each chapter, In the teaching plan each chapter has 4 hours' lecture time. However, chapter 3 and 5 are very long, which look hard to finish all contents within 4 hours. Given limited time, I would suggest to think about if the last chapter focused on a practical topic is really necessary for this course. There is also one minor suggestion for word documents presenting the experiments. Those documents are quite hard to read, because codes and texts use the same color and font. It is better to use different color to improve the legibility.

	In conclusion, this course is well designed and materials are comprehensive. The teaching method is appropriate, while the design of the chapters may need minor revision given limited time for each chapter. Based on my evaluation, this course will meet the teaching objectives.

5.3 Critical Thinking Oriented BigData

Module Contributors: Yueyue Li
Module Trainers: Yueyue Li
Skill Level: Intermediate
Module Assessment: Assignment, Project presentation, Assessment rubric for teamwork
Course Arrangement: 12 hours
Evaluation Method: Quiz at the end + Questionnaire (learning material + Teaching method)

Internal Reviewer's Name	**Dr. Qiwei Han**
Position	**Lecturer**
Organization (University/Company)	**Chengdu University**
Date Review Completed	**2021/11/22**
Instructional Design Eléments Score	**46/60**
Content Score	**17/25**
Suggestions	Illustrate critical thinking through more life examples.

External Reviewer's Name	**Dr. Yuanping Xu**
Position	**Professor**
Organization (University/Company)	**Chengdu University of Information Technology**
Date Review Completed	**2021/8/21**
Instructional Design Eléments Score	**44/60**
Content Score	**18/25**
Suggestions	Critical Thinking is a key tool in research methodology domain, and it can be gracefully applied in Bigdata based decision making improvements through ensuring the data quality. Thus, it's a wonderful teaching exploration. I wonder that this module has some improvements :

	1. Please enrich and detail the contents in PPT and other course materials to support the 12 teaching hours. 2. The primary task of this module is to discuss and clarify how critical thinking contributes the Bigdata applications. Many abstract concepts and jargons for both critical thinking and Bigdata have been involved in the PPT slides, but the how to build the bridge between the two sides are largely ignored, so it is difficult for me to understand. Some case studies from SMEs may be benefit the understanding. Furthermore, personally, I am very interest on how SWOT strategy can be applied in critical thinking oriented Bigdata, but I can find any concrete information in the current course materials. 3. Please further clarify the linkages between some teaching contents and the critical thinking to further justify that the teaching contents can support the module outcome, i.e., students will be able to critically analyze and evaluate data quality, making rational decisions. For instance, data visualization, business modeling and critical thinking? Please make the slides more logical to read and understanding. 4. Some mistakes in PPT and other course materials, e.g. duplicated sentences on PPT pp.18.

5.4 Smart Decision Making with BigData

Module Contributors: Da Shi
Module Trainers: Da Shi
Skill Level: Expert
Module Assessment: Assignment, Project presentation, Assessment rubric for teamwork
Course Arrangement: 16 hours
Evaluation Method: Quiz at the end + Questionnaire (learning material + Teaching method)

Internal Reviewer's Name	**Dr. Jin Wang**
Position	**Associate Professor**
Organization (University/Company)	**Chengdu University**
Date Review Completed	**2021/**
Instructional Design Eléments Score	**43/60**
Content Score	**17/25**
Suggestions	If necessary, please add some interesting examples to the teaching materials.

External Reviewer's Name	**Dr. Yu Jiang**
Position	**External Professor**
Organization (University/Company)	**Northwest A&F University, China**
Date Review Completed	**2021/11/20**
Instructional Design Eléments Score	**44/60**
Content Score	**18/25**
Suggestions	Nowadays, data processing and data analysis are becoming more and more important. Thus, it's a wonderful teaching exploration. I wonder that this module has some improvements: 1. Please enrich the contests in PPT. For example, in section S1, Designers can use a practical example to tell students why we should learn data analysis methods, which can improve the enthusiasm of students. 2. Data processing, data analysis and data visualization can be combined with mainstream Python or R language to introduce how they implement these processes. 3. PPT is not standard, Chinese and English mix and match. 4. Many methods for data processing and data analysis have been involved in the PPT slides, but the introduction of these theory is rather boring, so it is difficult for students to understand. Case studies can run through the whole course content. In these cases, designers can introduce where and how to use the data processing methods, and where and how to use the data analysis methods.

5.5 Data Mining Ideology and Technology

Data Mining Ideology and Technology (DMIT)

Module Contributors: Yuefei Wang
Module Trainers: Yuefei Wang
Skill Level: Intermediate
Module Assessment: Assignment, Project presentation, Assessment rubric for teamwork
Course Arrangement: 24 hours
Evaluation Method: Quiz at the end + Questionnaire (learning material + Teaching method)

Internal Reviewer's Name	**Dr. Lei Mou**
Position	**Lecturer**
Organization (University/Company)	**Chengdu University**
Date Review Completed	**2021/10/9**
Instructional Design Eléments Score	**47/60**
Content Score	**20/25**
Suggestions	This course has clear objectives and rich contents. But PPT can be more standardized, such as some format problems.

External Reviewer's Name	**Dr. Min Yao**
Position	**External: Principal 3D Engineer**
Organization (University/Company)	**3D Engineer**
Date Review Completed	**2021/9/6**
Instructional Design Eléments Score	**46/60**
Content Score	**19/25**
Suggestions	This course gives general concept of data mining combined with deep understanding and practice of the most important Data mining techniques today. The course starts with an introduction chapter giving a global view of the course: the concepts, the historical background, global picture of the techniques used as well as its relationship with other complexes problem dealing progresses. Then in the rest chapters dive into key techniques, major tools and algorithms. The course is very well designed. The objective of the course is to train students capable of mastering the key technologies of data mining, solving an issue with proper approaches and tool. From the teaching plan, one can easily get that the design focus on practical ability, experimental learning being the major part of the course. Every theoretical lecture is followed by a coherent case training. In order to enhance students' understanding, every concept is followed by one or several examples. I believe students can easily follow chapter by chapter and in the end be able to solve a real-world problem with the skills.

	The training material is well prepared. Font and color are carefully used to emphasize the key points. Figures and charts are properly presented as complementary of the lecture. It seems the PowerPoint content comes from author's book; sometimes we see wrong numbering of the title or example. However, this is just detail, not an issue at all. I highly appreciate the design of the course. Many examples and practical cases are included, making such senior course easy to understand and to follow. Students shall be able to meet the course expectation at the end.

Overall improvement action

The overall improvement actions from five modules have been divided into two parts: The instruction design element and the content. Regarding the instruction design element, the codes and texts in the word documents that present the experiments are used in different colour and font to improve the legibility. In addition, some mistakes in the PPT and other course materials, such as wrong numbering of the title or example and duplicated sentences, were adjusted to be more appropriate to all the trainee. According to the content of the learning materials, all of the suggestion are about the real example was not sufficient. As a result, the content of the learning materials has added up more examples or showcase which was the case study from the real sector or company. Case studies can run through the whole course content to be better understand by the students.

6. Training of the Trainers Sessions

After the partners CUIT and CDU finished the learning materials development and revision, Training of the Trainers (ToT) sessions were conducted. For domain 2: Software Engineering and Big data analysis, the ToT were conducted in 2 parts, each parts covering different modules. Due to the COVID-19 situation, we firstly record the training materials and ask the trainers learn by themselves. In order to know whether the teaching materials is effective or not, we deliver questioners to the trainers. Secondly, the ToT for domain 2 were planned to be held physically. Since CUIT and CDU in the same city, we conducted face-to-face course discussions and analysis.

6.1 Part 1

First part of ToT for domain 2 is held virtually from 1st June to 1st December 2021. Given that this part of ToT was held virtually during the pandemic, modules selected for the training are shown in the following: 1). Principle and Application of BigData Technology; 2). Critical Thinking Oriented BigData; 3). Data Mining Ideology and Technology.

The poster figures shown in Figure 2. gives the concurrent arrangement of the class time and place.

Figure 2. Domain 2 ToT Part 1 Poster: 《Data Mining Ideology and Technology》; 《Critical Thinking Oriented BigData》; 《Principle and Application of BigData Technology》

6.1.1 Part 1 Description

Part 1 of the ToT for domain 2 was held (90 hours) from June to December. Based on the sequence relationships of courses, the first stage we started from the following three courses : 《Data Mining Ideology and Technology,《Critical Thinking Oriented BigData, and《Principle and Application of BigData Technology. As for these three courses, we have done online. Detailed number of attendees for each modules are as follows :

ToT Module	Number of Participants
Data Mining Ideology and Technology	**12**
Critical Thinking Oriented BigData	**12**
Principle and Application of BigData Technology	**7**
Total	**31**

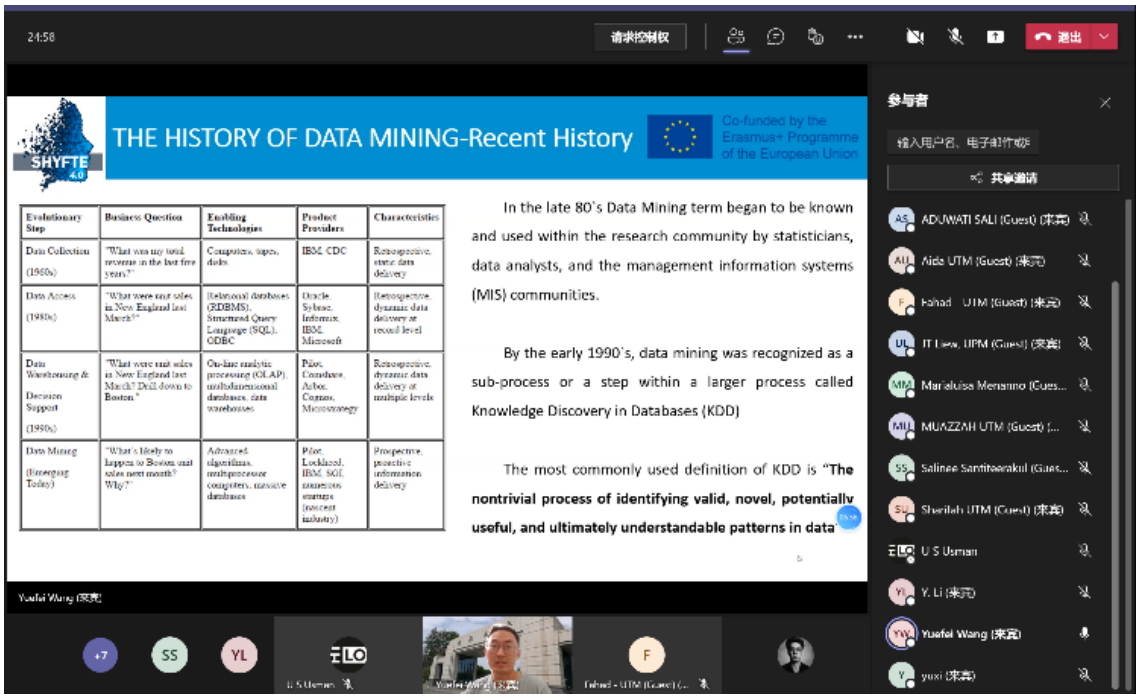


Figure 3: Picture of trainer and attendees for module 《Data Mining Ideology and Technology》 on 29th June

Figure 4: Picture of training for module 《Data Mining Ideology and Technology》 on 1st, July.

Figure 5: Picture of training for module 《Data Mining Ideology and Technology》 on 2nd, July.

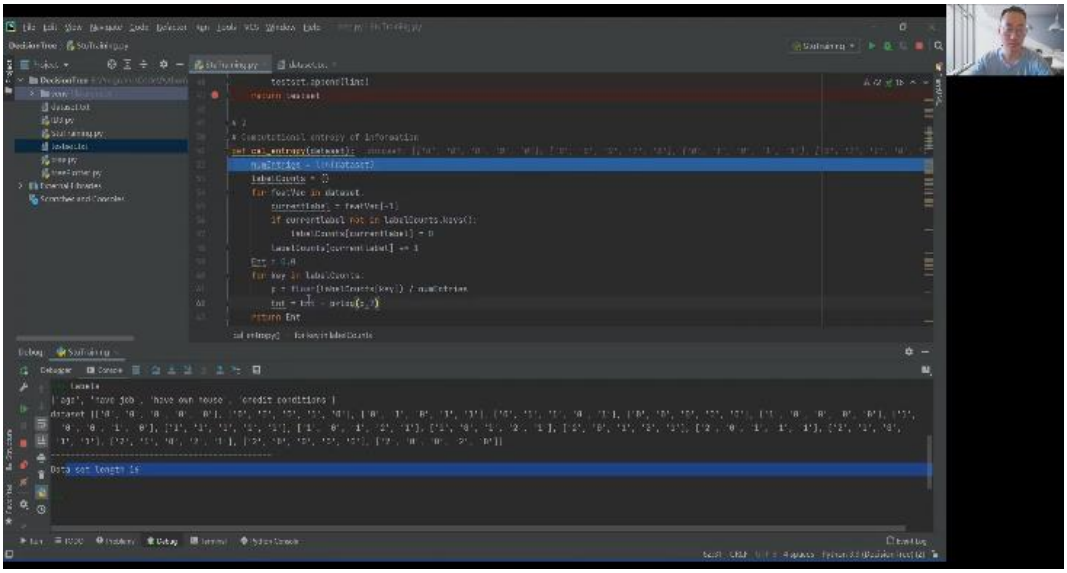


Figure 6: Picture of training for module 《Data Mining Ideology and Technology》 on 3rd, July.

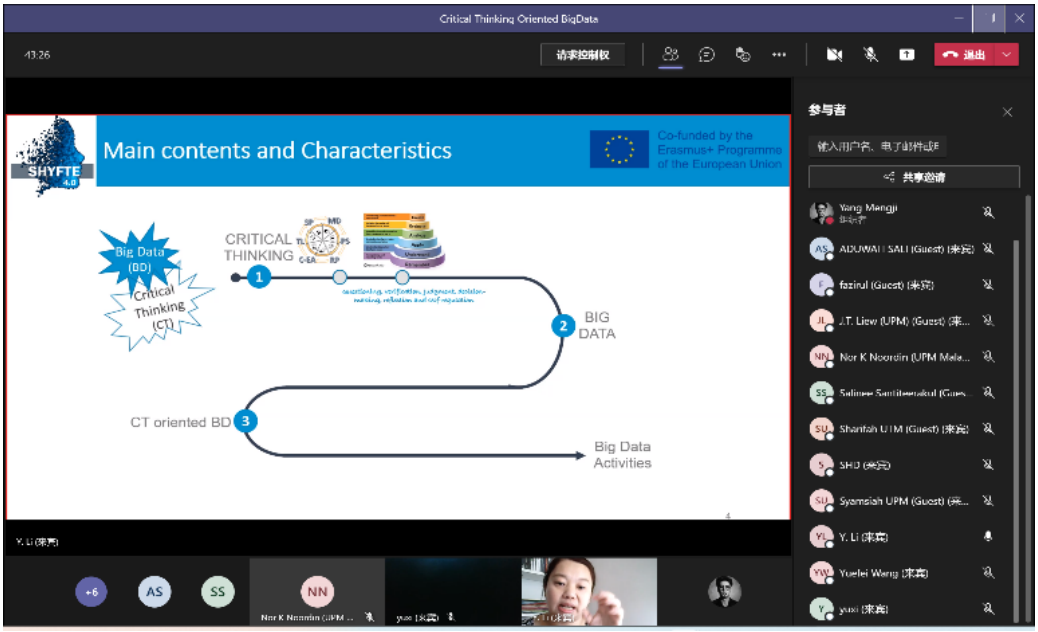


Figure 7: Picture of trainer and attendees for module 《Data Mining Ideology and Technology》 on 30th, June

Figure 8: Picture of training for module 《Data Mining Ideology and Technology》 on 7th, July

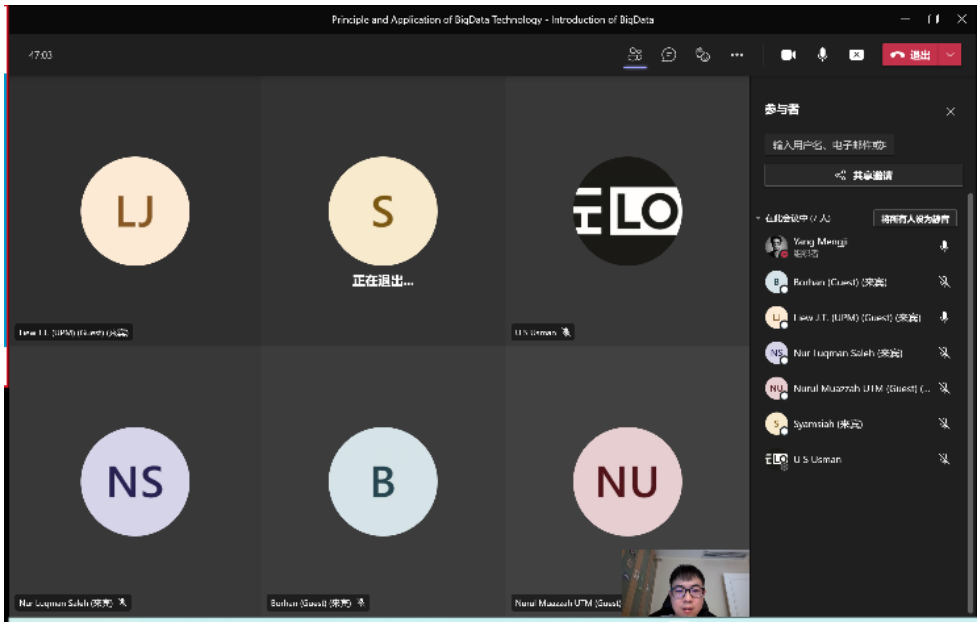


Figure 9: Picture of trainer and attendees for module 《Principle and Application of BigData Technology》 on 12th,July.

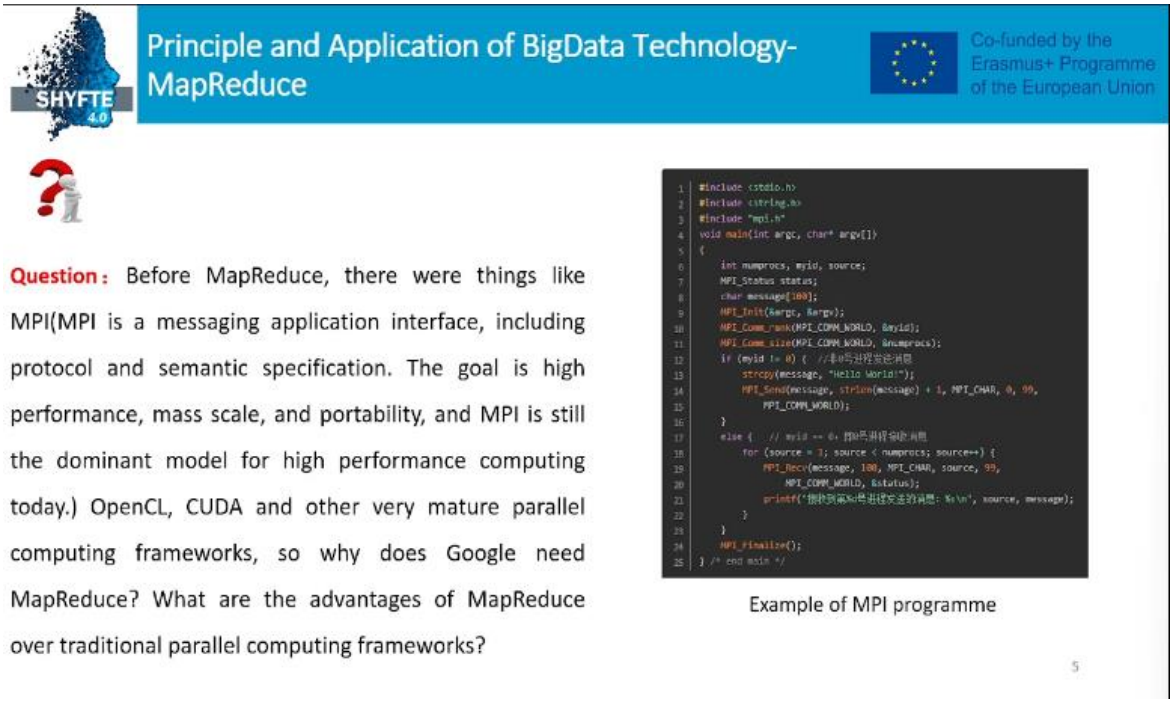


Figure 10: Picture of training for module 《Principle and Application of BigData Technology》 on 14th,July.

6.1.2 Part 1 Feedback

Satisfaction questionnaires were provided to all attendees to collect their feedback on quality of the ToT. We have conducted the course satisfaction analysis, which is shown in Figure 11. From the collected responses, the attendees are generally satisfied with the ToT sessions. The inclusion of practical use cases also enhances the appreciation of the attendees on the knowledge shared.

Module Title	Number of Respondents
Data Mining Ideology and Technology	10
Critical Thinking Oriented BigData	10
Principle and Application of BigData Technology	10

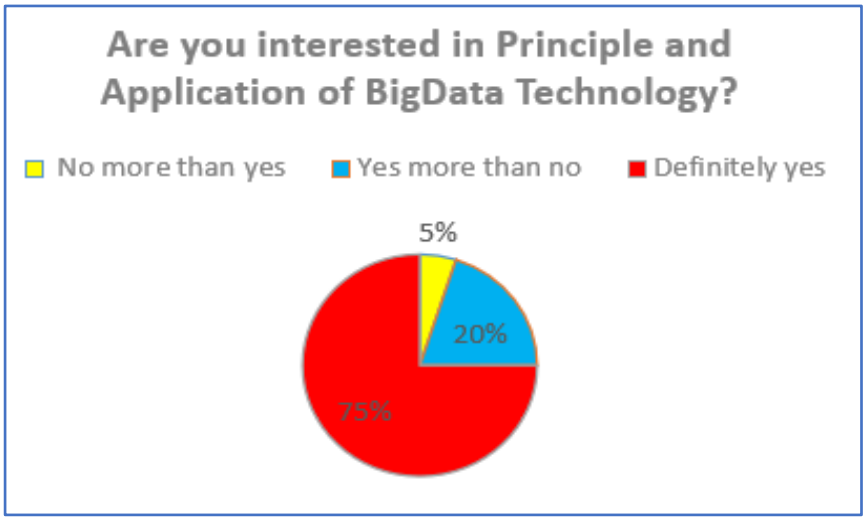


Figure 11-1. Course satisfaction survey analysis- Principle and Application of BigData Technology

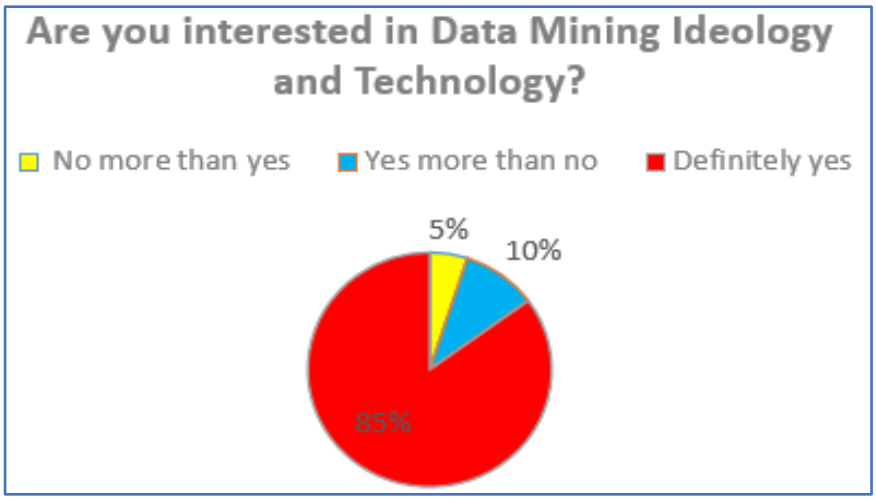


Figure 11-2. Course satisfaction survey analysis- Data Mining Ideology and Technology

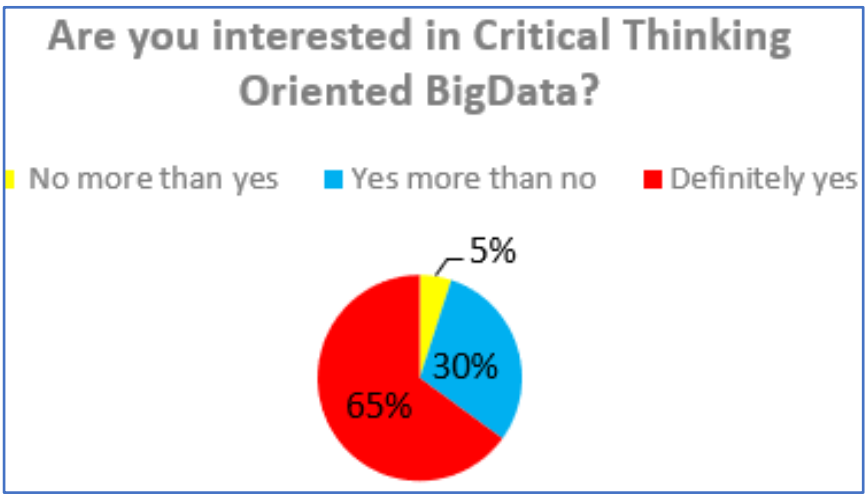


Figure 11-2. Course satisfaction survey analysis- Critical Thinking Oriented BigData

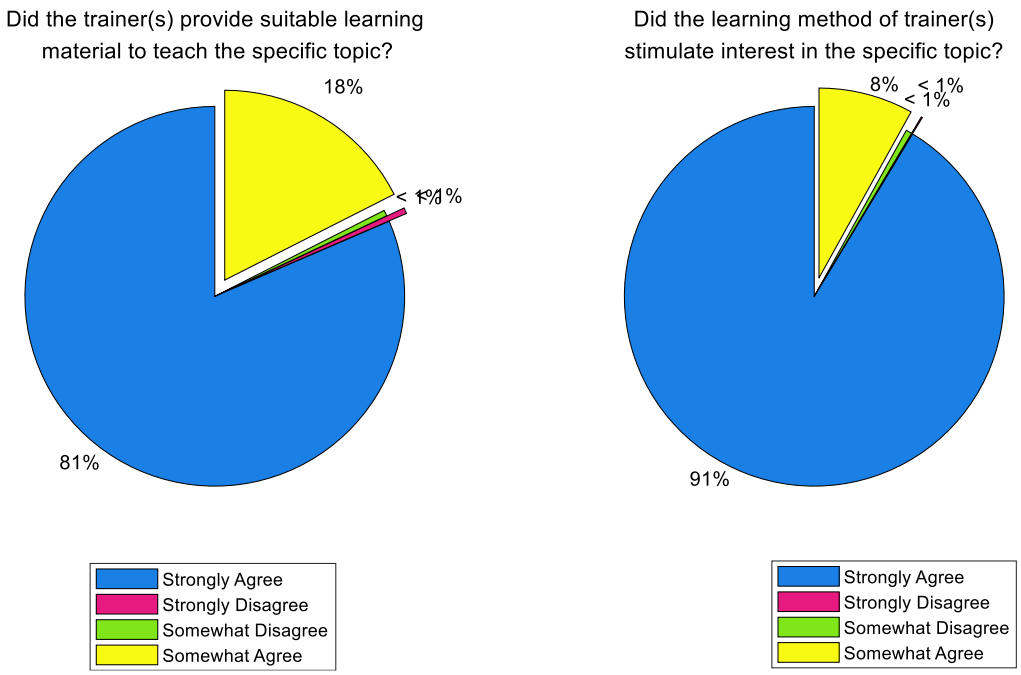


Figure 12-1. Survey Analysis Result-Part 1

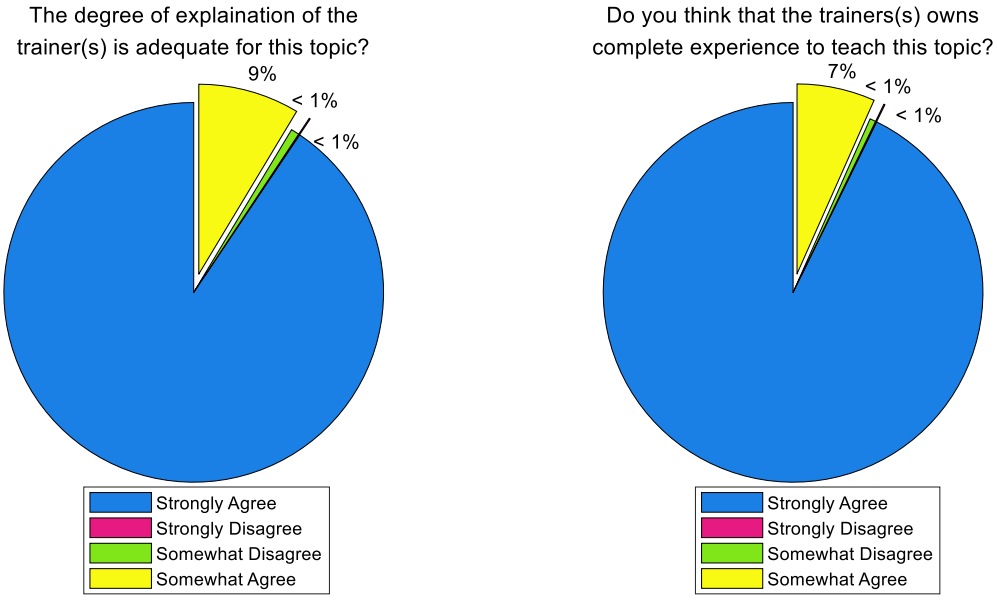


Figure 12-2. Survey Analysis Result-Part 2

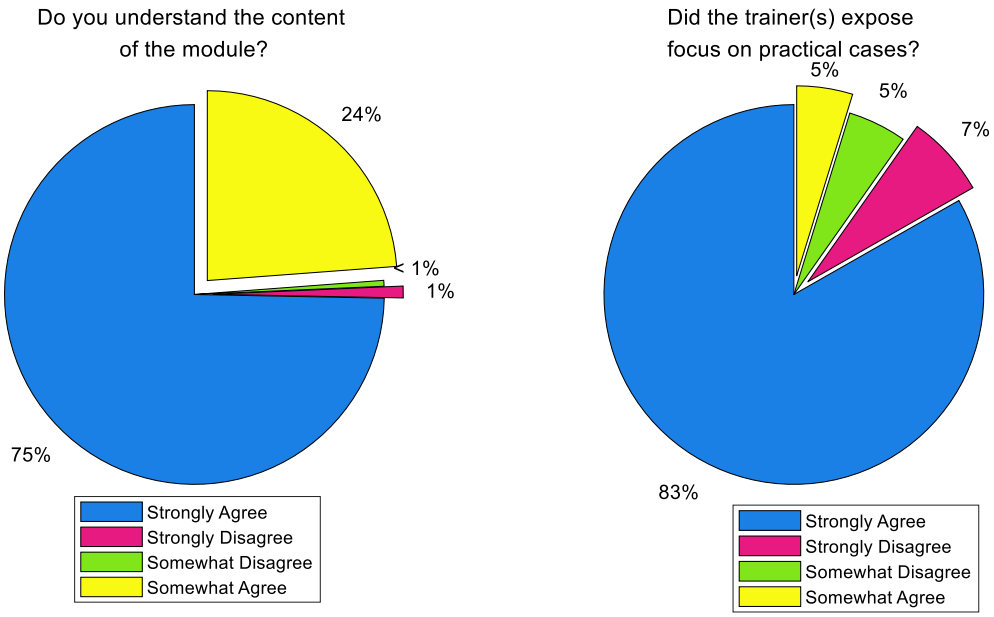


Figure 12-3. Survey Analysis Result-Part 3

6.2 Part 2

Second part of ToT for domain 2 has been conducted by offline teaching. Second part involves more hands-on with the usage of purchased equipment and software. In this part, we used the purchased recording equipment, collected the students' classroom expression data, and analyzed the students' learning situation.

In November, we recorded the rest courses: 《Comprehensive Training of Artificial Intelligence 》and 《Smart Decision Making with BigData. As for these two modules, we firstly recorded the class and then uploaded the resources online via link **ftp://nelsa.cn/**. Finally, we did face-to-face course communication.

Figure 13. Domain 2 ToT Part 2 Poster

6.2.1 Part 2 Description

Domain 2 ToT Part 2 was planned to be held physically with live demonstration of the equipment handling. This part has used the purchased servers, video recording equipment, Printers, projectors, and PCs.

ToT Module	Number of Participants
Comprehensive Training of Artificial Intelligence	**20**
Smart Decision Making with BigData	**10**
Total	**30**

As for the courses《Comprehensive Training of Artificial Intelligence》and 《Smart Decision Making with BigData》, We adopted the methods of pre-class discussion, in-class discussion, and post-class analysis.

Figure 14. Domain 2 ToT Part 2: pre-class discussion

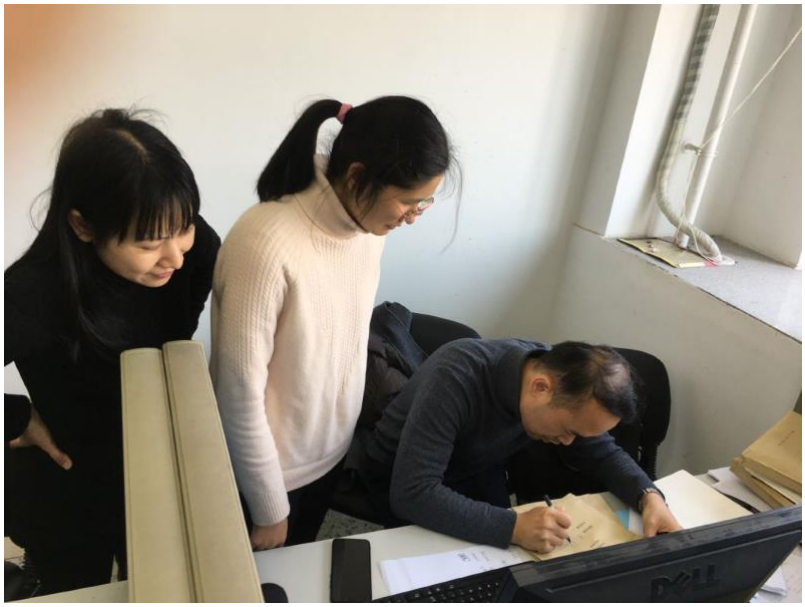


Figure 14. Domain 2 ToT Part 2: in-class discussion (Comprehensive Training of Artificial Intelligence)

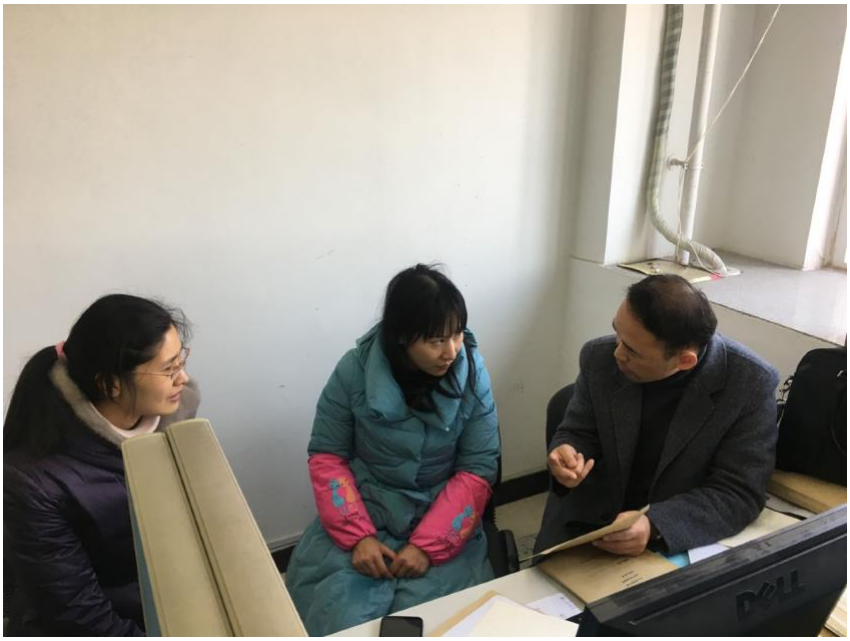


Figure 15. Domain 2 ToT Part 2: in-class discussion (Comprehensive Training of Artificial Intelligence)

Figure 16. Domain 2 ToT Part 2: post-class analysis (Comprehensive Training of Artificial Intelligence)

Figure 17. Domain 2 ToT Part 2: in-class discussion (Smart Decision Making with BigData)

Figure 18. Domain 2 ToT Part 2: in-class discussion (Smart Decision Making with BigData)

Figure 19. Domain 2 ToT Part 2: in-class discussion (Smart Decision Making with BigData)

6.2.2 Part 2 Feedback

Similar to ToT Part 1, satisfaction questionnaire were distributed to all attendee for feedback collection. Based on the 30 responses collected, the audience are much more satisfied with the ToT sessions with every respondent have positive responses.

Module Title	Number of Respondents
Comprehensive Training of Artificial Intelligence	20
Smart Decision Making with BigData	10

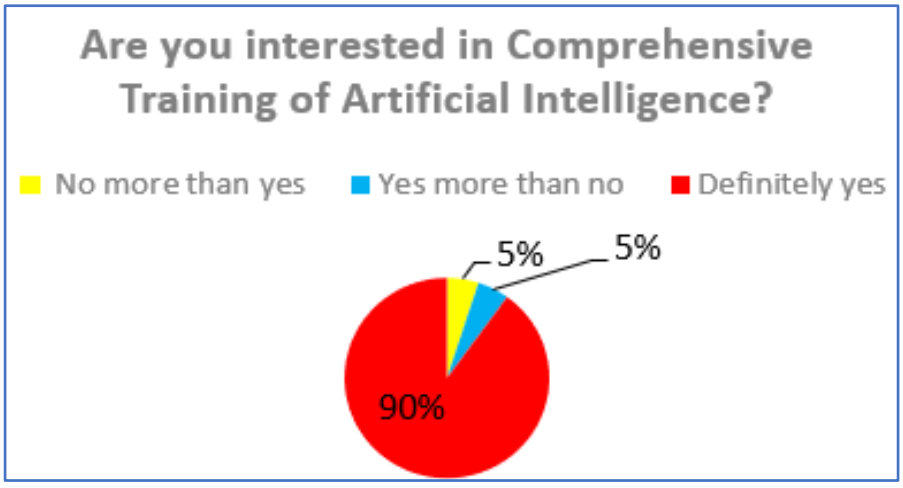


Figure 19-1. Course satisfaction survey analysis- Comprehensive Training of Artificial Intelligence

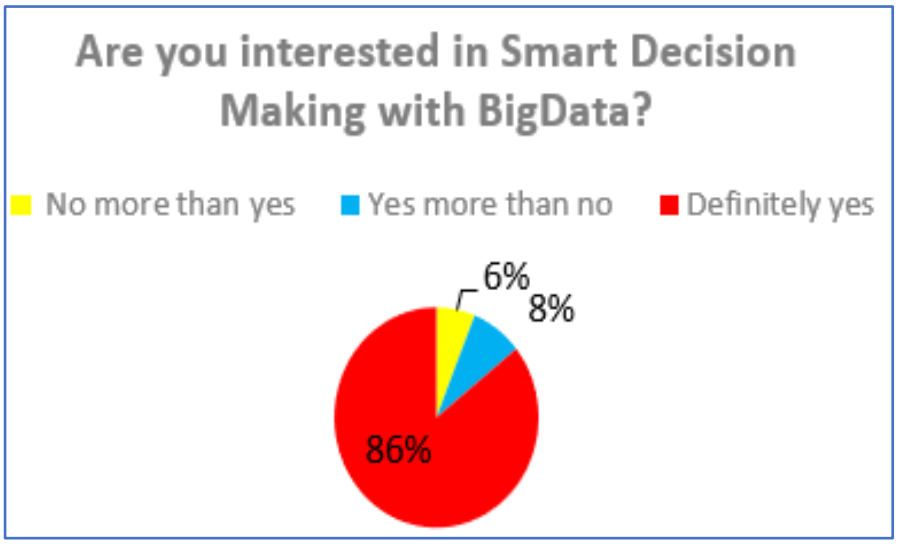


Figure 19-2. Course satisfaction survey analysis- Smart Decision Making with BigData

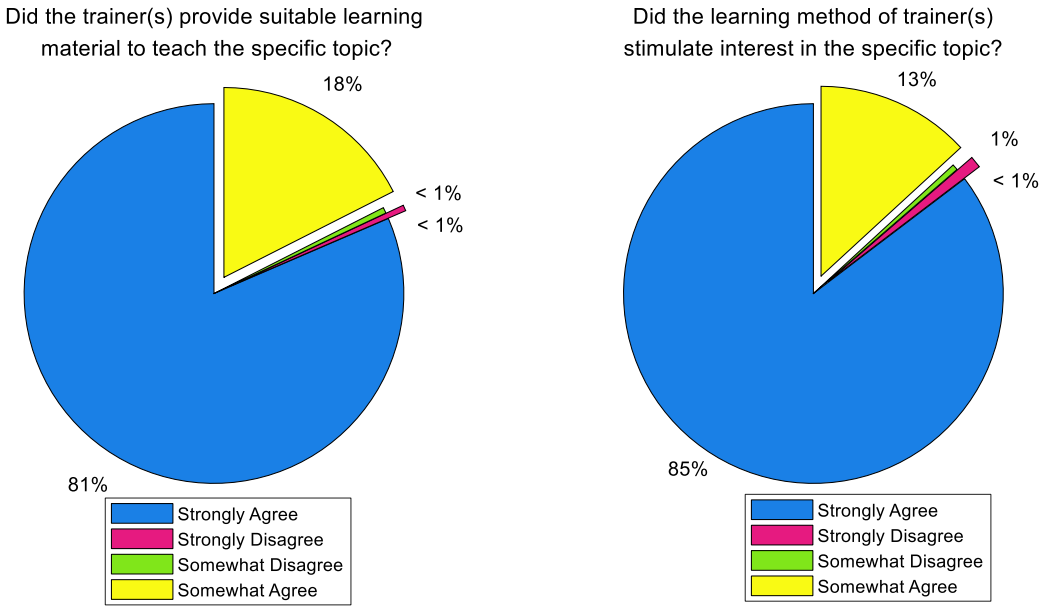


Figure 20-1. Survey Analysis Result-Part 1

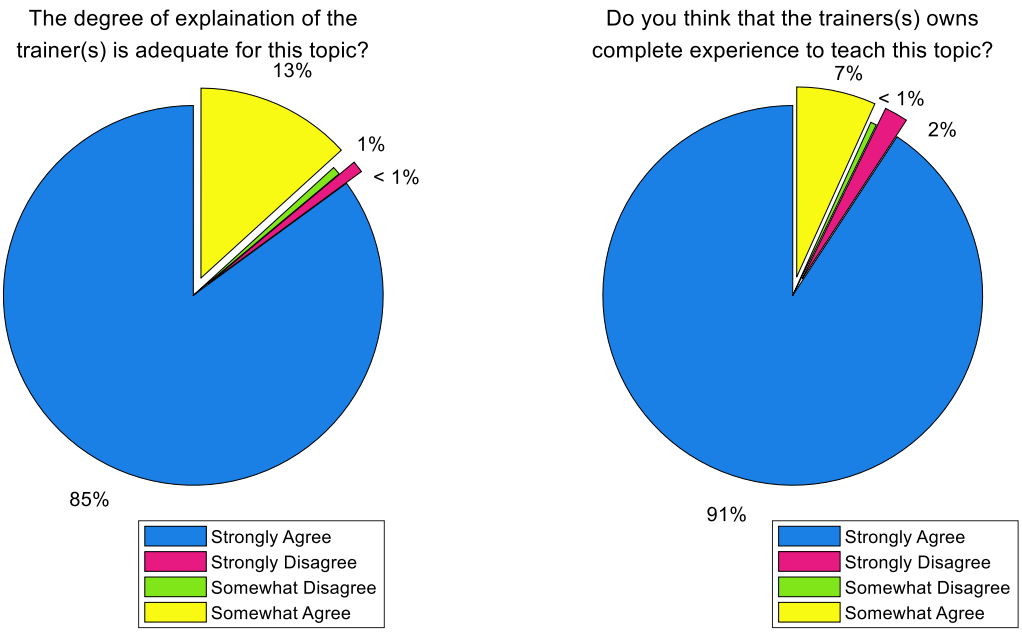


Figure 20-2. Survey Analysis Result-Part 2

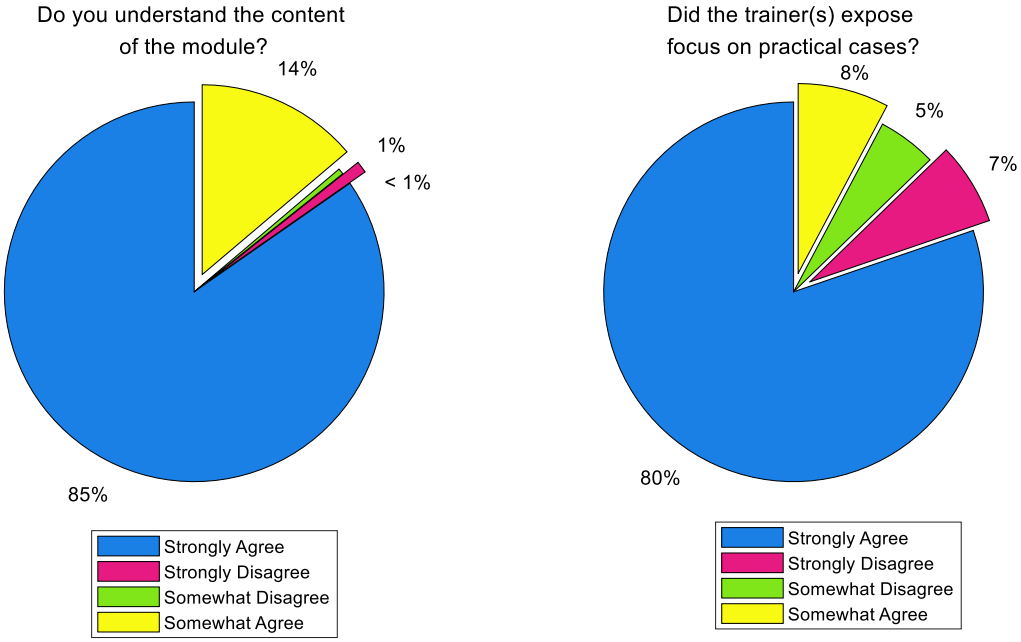


Figure 20-3. Survey Analysis Result-Part 3

7. Training of the Students Sessions

The Shyfte 4.0 Training of Students (ToS) for Pilot 2 Software Engineering and Big Data Analysis have been conducted from 14 March to 20 June 2022. The participants are first year postgraduate students from Software Engineering, Electronic Information and Agricultural Engineering, and Information Technology.

7.1 ToS Session Details

The ToS was held from 24th March to 20th, June, 2022, which is shown in the following:

Date	Day	Time	Venue	Module	Trainer	No. of students
8-9 April 2022	Friday and Saturday	7:00-9：00 PM	CUIT B503	Principle and Application of BigData Technology	Yang Mengji	74
24 March-15 April 2022	Wednesday	7:00-9：00 PM	CUIT H4301	Comprehensive Training of Artificial Intelligence	Dr. Zhang Haiqing	74
18 April - 20 June 2022	Tuesday	14:00 - 16:00	CUIT H4301	Smart Decision Making with BigData	Prof. Xu Yuanping	40
14-15 May 2022	Sunday	14:00 - 17:00	Online	Critical Thinking Oriented BigData	Dr. Yueyue Li	10
21-22 May 2022	Sunday	14:00 - 15:00	Online	Data Mining Ideology and Technology	Dr. Yuefei Wang	10

The posters for communication plan are as shown in the following:

Figure 21-1 : Posters for ToS-Part 1

Figure 21-2 : Posters for ToS-Part 2

7.1.1 Session 1 Description

In general, the ToS has received excellent participations from the students. We have conducted the training of students in CUIT and CDU. In CUIT, we have done the courses of “Comprehensive Training of Artificial Intelligence”, Principle and Application of BigData Technology”, and “Critical Thinking Oriented BigData”.

As for the module “Comprehensive Training of Artificial Intelligence”, which is an important discipline to teach the professional knowledge of artificial intelligence and the related machine learning topic. We have trained 74 students in this module and we did the training offline. These students are mainly master students.

Figure 22-1 : TOS for module Comprehensive Training of Artificial Intelligence

Figure 22-2 : TOS for module Comprehensive Training of Artificial Intelligence

Figure 22-3 : TOS for module Comprehensive Training of Artificial Intelligence

Figure 22-4 : TOS for module Comprehensive Training of Artificial Intelligence

As for the module “Smart Decision Making with BigData”, which mainly introduces common data analysis knowledge and skills as well as intelligent decision-making based on data analysis. 40 students joined this module.

Figure 23-1 : TOS for module Smart Decision Making with BigData

Figure 23-2 : TOS for module Smart Decision Making with BigData

As for the module “Principle and Application of BigData Technology, this module introduces the principal technology of BigData.

Figure 24: TOS for module Principle and Application of BigData Technology

A total of 120 students attended in this session, which are listed in the following table:

No.	Student Name	Student Number	Contact information
1	Fanlin Meng	3210704001	15928129303
2	Junyu Yu	3210704002	17744630839
3	Zhuoran Chen	3210704003	13628513617
4	Hao Zeng	3210704004	18582661707
5	Qi Xue	3210704005	13568908396
6	Minjun Sun	3210704006	18715794736
7	Juehan Peng	3210704007	18508138079
8	Huahao Chen	3210704008	18283808036
9	Jiacheng Xie	3210704009	13540559300
10	Qian Luo	3210704010	13698327081
11	Fan Zhang	3210704011	15281285321
12	Jiangmin Li	3210704012	17691086153
13	Guofu Tang	3210704013	13629041032
14	Weichao Xiong	3210704014	19150711225
15	Bo Cai	3210704015	18227350731
16	Guangyao Chen	3210704016	15882059118

17	Yong Yu	3210704017	13061323861
18	Wenxin Wang	3210704018	17398899967
19	Rui Qing	3210704019	17781290405
20	Tao Xu	3210704020	15984389399
21	Zengwei Zhang	3210704021	15698244829
22	Haitao Zhao	3210704022	13699683844
23	Chengxin Zhong	3210704023	15983324463
24	Junfei Xie	3210704024	18381097751
25	Haoyuan Li	3210704025	18080715992
26	Shaofeng Wu	3210706001	17737017361
27	Peng Cheng	3210706002	19922245252
28	Dingsheng Yuan	3210706003	18702706008
29	Liqiong Ran	3210706004	13002202670
30	Zhengjiang Ma	3210706005	15928432771
31	Junyu Deng	3210706006	17361058436
32	Ruqie Li	3210706007	13350932937
33	Gnegyuan Hu	3210706008	17378767751
34	Xiaohao Lu	3210706009	17394945027
35	Nan Xiao	3210706010	15181224735
36	Kanglei Xu	3210706011	13931521052
37	Zongheng Luo	3210706012	18015751572
38	Tiancheng Xie	3210706013	13111856935
39	Xiaohui Luo	3210706014	13708216181
40	Na Lin	3210706015	18081733441
41	Wenjie Deng	3210706016	13037711951
42	Yang Liu	3210706017	18180536360
43	Jianjie Ye	3210706018	18380297504
44	Cong Li	3210706019	17760481384
45	Jing Li	3210706020	18284814107
46	Yijie Zhang	3210706021	17796418162
47	Lin Shi	3210706022	13935396300
48	Xu Zhang	3210706023	15275035530
49	Shengjie Luo	3210706024	17855999298
50	Fan Luo	3210706025	19882445702
51	Chen Wang	3210706026	13982455414
52	Tieyuan Hong	3210706027	17396222660
53	Chenxi Yang	3210706028	19983524690
54	Yuan Cao	3210706029	18583752590
55	Guokang Gao	3210706030	18782128216

56	Meichen Hu	3210706031	15892432737
57	Li Yuan	3210706032	18223683385
58	Xin Yang	3210706033	13419364667
59	Bin Pan	3210706034	15908441653
60	Yu Nie	3210706035	13795916030
61	Rongqiang Gou	3210706036	17612823595
62	Yong Wu	3210706037	13550103107
63	Tao Liu	3210706038	18402881461
64	Liping Wang	3210706039	18111075451
65	Fengyue Xiong	3210706040	18011524924
66	Ziyu Wang	3210706041	13408380345
67	Yue Li	3210706042	13880226883
68	Yu Lei	3210706043	15351202920
69	Zheng Tian	3210706044	13628117324
70	Yiyang Mi	3210706045	18779394102
71	Hui He	3210706046	15874461912
72	Zihan Huang	3210706047	13908044064
73	Xi Zhang	3210706048	15983463152
74	Yang He	3210706049	13281159017
75	Peilun Han	3210706050	15108435595
76	Qirui Jiang	3210706051	18628331392
77	Weilai Pu	3210706052	18398311505
78	Zequan Liao	3210706053	15608236371
79	Changwu Wang	3210706054	18982727859
80	Linfeng Dai	3210706055	13734905487
81	Qi Tang	3210706056	17683181807
82	Jueqi Liu	3210706057	15828876513
83	Jinchuan Kang	3210706058	18200383560
84	Yang Wang	3210706059	15196737699
85	Qun Zhu	3210706060	18783175114
86	Wen Jiang	3210706061	17851371925
87	Qiantong Yu	3210706062	17394943871
88	Nianqing Wei	3210706063	15881739657
89	Yue Li	3210706064	18200161278
90	Sichang Jiang	3210706065	17790360991
91	Kunwei Liao	3210706066	19182157003
92	Lang Yan	3210706067	13258213158
93	Lijun Li	3210706068	15729883663
94	Minghui Zhang	3210706069	13028103069

95	Xianghong Dong	3210706070	13361182539
96	Yinghu Liu	3210706071	15928777539
97	Guojiang Cao	4210705001	13882138745
98	Xiaojun Zhu	4210705002	13808079115
99	Yan Gu	4210705003	17381597114
100	Jiang Wang	4210705004	18684031132
101	Jiangang Gu	4210705005	18113195275
102	Qi Shen	4210705006	15208470024
103	Shaobin Bian	4210705007	15771806618
104	Yue Hu	4210705008	15882139001
105	Xiaodong Zhang	4210705009	18980861076
106	Junming Fan	4210705010	15378577771
107	Shenglong Wang	4210705011	15281074996
108	Linpo Luo	4210705012	18381652029
109	Xiao Wang	4210705013	13540704349
110	Huanyi Luo	4210705014	18428320322
111	Haibin Xiao	4210705015	13730693919
112	Bo Xu	4210705016	15937082993
113	Qingyong Liu	4210705017	18225126243
114	Jin Zhang	4210705018	13880564705
115	Junzhi Deng	4210705019	18080178537
116	Gaoxin Liu	4210705020	15928725360
117	Yanwen Mo	4210705021	15277339298
118	Hanfu Gou	4210705022	18381691715
119	Tao Zhu	4210705023	17711081716
120	Houqiang Liu	4210705024	18215593580

7.1.2 Session 1 Feedback

The feedback received from students was very encouraging such that more than 90 percent respondents were interested with the content of the modules. As for individual topic attended, the survey asked 17 questions ranging from items about students' knowledge, modules materials, module workload, evaluation, etc. A total of 120 students attended the three modules with the distribution shown in Table 6.1.2 (a).

Table 6.1.2(a) Summary of Students' Feedback

No.	Modules	Percentage of Responses
1.	Comprehensive Training of Artificial Intelligence	95%
2.	Smart Decision Making with BigData	93%
3.	Principle and Application of BigData Technology	92%

The response to individual question was summarised in Table 6.1.2.

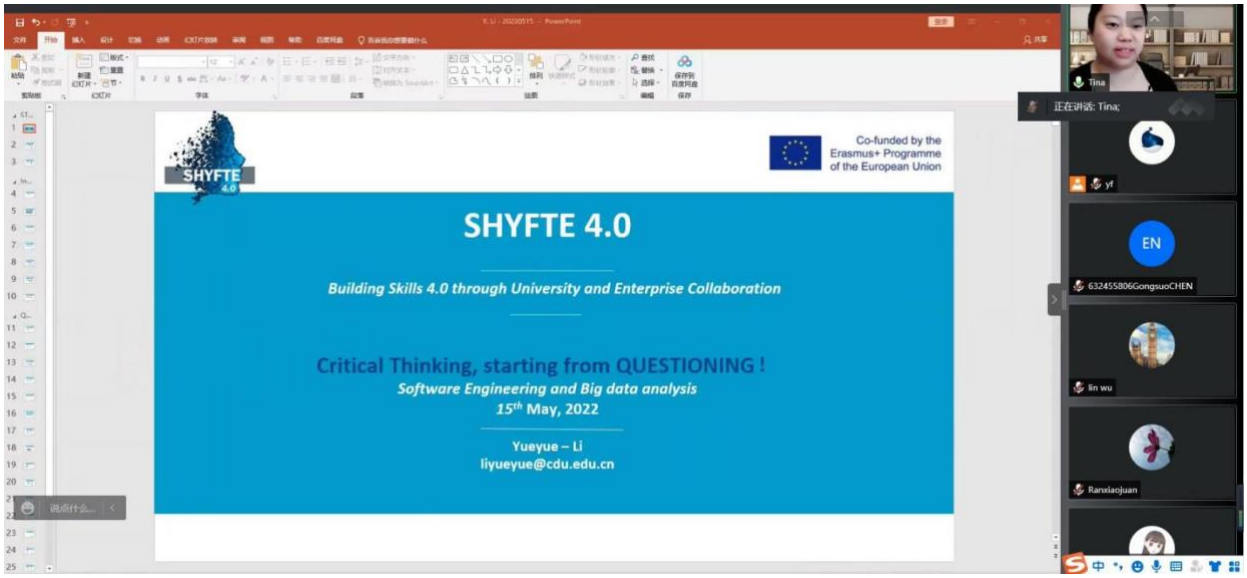
Table 6.1.2(b) Summary of Students' Feedback

No.	Description	Percentage of Satisfaction
1.	Preliminary knowledge owned sufficient to understand the material	100%
2.	Teaching workload proportional to work assigned	100%
3.	Teaching material suitable for the study of the topic	96%
4.	Evaluation methods are clearly defined	100%
5.	Lessons, exercises, and teaching activities carried out in accordance with timetable	100%
6.	Teacher stimulate/motivate interest to the topic	98%
7.	Teacher explains topic is clear	100%
8.	Teaching activities useful for learning the topic	96%
9.	Teacher is available for clarification and explanation	95%
10.	Interested in the topic covered	93%
11.	Students developed new skills and abilities	99%
12.	Degree of achievement of the objectives	100%
13.	Keep the class schedule	100%
14.	Always cooperative	95%
15.	Shown proper communication	94%
16.	Use specific and appropriate language	92%
17.	Perform assigned tasks, respecting time and method	95%

7.2 Session 2

CDU has done the course of "Critical Thinking Oriented BigData" and "Data Mining Ideology and Technology" online in the second period.

As for the module "Critical Thinking Oriented BigData", which will make students build up consciousness of critical thinking and, through case studies and group-based activities, clearly understand the relationship of critical thinking and big data analytics, inspiring them to apply thinking skills to deal with the big data challenges.



As for the module “Data Mining Ideology and Technology”,

A total of 22 students attended in this session, which are listed in the following table:

No.	Name	Stu.ID	Contact Information	Institution
1	Xiaojuan Ran	632455818	xiaojuan_ran@cmu.ac.th	Sichuan Tourism University
2	Chengyi yang	632455822	chengyi_yang@cmu.ac.th	
3	Xiaoxia Wen	632455831	xiaoxia_w@cmu.ac.th	
4	Xiao Chen	642455819	xiao_c@cmu.ac.th	
5	Lan Fang	632455827	lan_f@cmu.ac.th	
6	Chunman Zhu	632455823	chunman_zhu@cmu.ac.th	
7	Dandan Liu	632455824	dandan_liu@cmu.ac.th	
8	Gongsuo Chen	632455806	gongsuo_chen@cmu.ac.th	
9	Hua Zhang	632455826	hua_zhang@cmu.ac.th	
10	Wang Mei	632455830	wang_mei@cmu.ac.th	
11	Xiaoling Liu	632455828	xiaoling_liu@cmu.ac.th	
12	Bo Liu	632455821	bo_liu@cmu.ac.th	
13	Hongmei Shu	632455815	hongmei_shu@cmu.ac.th	Chengdu University
14	Xiaoying Li	632455819	xiaoying_l@cmu .ac. th	
15	Lin Wu	632455817	lin_wu@cmu.ac.th	
16	LI zhao	632455816	li_zhao@cmu.ac.th	
17	Yaxian Ran	632455832	yaxian_ran@cmu.ac.th	
18	xuying zheng	632455810	xuying_zheng@cmu.ac.th	
19	Zuo Wang	642455811	zuo_wang@cmu.ac.th	
20	Liu Xingrui	202110411116	17308198116	
21	Guo Xiao Yan	202010911404	13028640887	
22	Chen Wei	202110430121	13154924752	

The feedback received from students was very encouraging such that more than 90 percent respondents were interested with the content of the modules. As for individual topic attended, the survey asked 17 questions ranging from items about students' knowledge, modules materials,

module workload, evaluation, etc. A total of 22 students attended the two modules with the distribution shown in Table 6.1.2 (a).

Table 6.1.2(a) Summary of Students' Feedback

No.	Modules	Percentage of Responses
1.	Critical Thinking Oriented BigData	99%
2.	Data Mining Ideology and Technology	100%

The response to individual question was summarised in Table 6.1.2.

Table 6.1.2(b) Summary of Students' Feedback

No.	Description	Percentage of Satisfaction
1.	Preliminary knowledge owned sufficient to understand the material	100%
2.	Teaching workload proportional to work assigned	100%
3.	Teaching material suitable for the study of the topic	100%
4.	Evaluation methods are clearly defined	100%
5.	Lessons, exercises, and teaching activities carried out in accordance with timetable	100%
6.	Teacher stimulate/motivate interest to the topic	95%
7.	Teacher explains topic is clear	96%
8.	Teaching activities useful for learning the topic	100%
9.	Teacher is available for clarification and explanation	99%
10.	Interested in the topic covered	94%
11.	Students developed new skills and abilities	96%
12.	Degree of achievement of the objectives	100%
13.	Keep the class schedule	100%
14.	Always cooperative	95%
15.	Shown proper communication	93%
16.	Use specific and appropriate language	96%
17.	Perform assigned tasks, respecting time and method	95%

8. Resources for Learning Materials

There are two categories of resources: public and private materials. Case study and some YouTube content are made public, while private files are uploaded to the project owncloud. The following section provides a comprehensive listing of the available resources

8.1 Public Materials

For the domain 2: Software Engineering and Big Data Analysis, we have some videos of the courses including Principle and Application of BigData Technology, Comprehensive Training of Artificial Intelligence, Critical Thinking Oriented BigData, Smart Decision Making with BigData, Data Mining Ideology and Technology.

Links to the above courses are below:

1. Principle and Application of BigData Technology: ftp://nelsa.cn/shyfte-China/PABT/
2. Comprehensive Training of Artificial Intelligence: ftp://nelsa.cn/shyfte-China/CTAI/
3. Critical Thinking Oriented BigData: ftp://nelsa.cn/shyfte-China/CTOB/
4. Smart Decision Making with BigData: ftp://nelsa.cn/shyfte-China/SDMB/
5. Data Mining Ideology and Technology: ftp://nelsa.cn/shyfte-China/DMIT/

8.2 Confidential Material

For the domain 2, we have some learning material documents for the five modules and some feedback from companies or university teachers. The links as below:

Learning materials link:

https://disp-ds.univ-lyon2.fr/owncloud/apps/files/?dir=/SHYFTE%20(3)/Approved%20Deliverables/Resources/Private/CDU&fileid=1382941

https://disp-ds.univ-lyon2.fr/owncloud/apps/files/?dir=/SHYFTE%20(3)/Approved%20Deliverables/Resources/Private/CUIT&fileid=1382943

Modules reviews:

https://disp-ds.univ-lyon2.fr/owncloud/apps/files/?dir=/SHYFTE%20(3)/WorkPackages/WP2_DEVELOPMENT/T2.2_LearningMaterials&fileid=1384578

9. Deviations or Mitigation Actions

During the execution and completion of the project, we completed the development of five modules. For example, one of the six modules expected to be developed has not yet been completed, so we incorporate the conception of the module into the five modules, and then trained the trainers and students, and conducted the corresponding evaluation and analysis.

There have been deviations and preventative measures taken throughout the course of the project's execution and completion. Because of COVID-19, a number of activities that were planned but never carried out as intended, particularly training modules that required hands-on instruction with specific equipment. It is made worse by the several lockdowns, which makes employment on campus illegal.

Trainers and students were required to participate in online classes that deviated from the original plan from 2020 through 2022. On the other hand, because of the pandemic situation was improving in 2022, the ToS training in domain 2 was changed to onsite training so that students could get hands-on experience with the various pieces of equipment that they would be learning to use.

10. Sustainability of SHYFTE Learnings Materials

In this project, CUIT and CDU focus on Domain 2 Software Engineering and Big Data Analytics. Based on this field, the modules jointly developed by CUIT and CDU are as follows: 1). Principle and Application of BigData Technology; 2). Critical Thinking Oriented BigData; 3). Data Mining Ideology and Technology; 4). Comprehensive Training of Artificial Intelligence; 5). Smart Decision Making with BigData.

The above modules not only meet the requirements of higher education under the background of industry 4.0, but also are the focus of many enterprises in the information age. The training of these modules is conducive to cultivating a large number of skilled talents for enterprises, so that the teaching, learning and enterprise requirements of student skills can form a harmonious system. In addition, in this project, the image data collected from the Learning Education Center is used to analyze students' learning situation, and students' learning efficiency and students' employability are analyzed through library and dormitory access data. The above data can also be applied in micro-expression recognition and multi-modal data processing. Not only that, the equipment involved in this project such as Mobile Workstation, Recording Host, HD Camera Management Software, Graphics Workstation, Digital Display Terminal, Black and White Laser Output Terminal, HD Camera can also be used to record and analyze sound and video data to solve new scientific problems. According to the feedback of this training, our students are very interested in these modules, and they are highly satisfied with all aspects of the course. This gives us the confidence to add new modules to the Learning Education Center.

As the first theme of the series course “Software Engineering and Big data analysis”, “Comprehensive Training of Artificial Intelligence” offers fundamental knowledge for big data analytics, aiming at training students to understand essential theory and practice application with experiments. The “Data Mining Ideology and Technology” module introduces the basic concepts of data mining, and combines the current important data mining technology to explain and practice. The other three modules introduce big data from the aspects of the basic knowledge of big data, the modeling of real big data problems, and the critical thinking of big data. The above several modules not only provide a lot of basic knowledge about big data and artificial intelligence, but also use the current popular technology to complete some small cases, which can serve as pilot courses for the new modules. Most importantly, we have a large number of computer-related majors who can devote themselves to the follow-up training.

The 5 modules are integrated in the Learning Centre developed during the project. It allows students and people from companies to customize the training based on their profile. They could also pick and choose the modules they are interested in as part of their lifelong learning should they choose not to customize their training. The participants will pay a minimum cost once the project ends. The Learning Centre will be maintained and managed by CDU and CUIT once the project ends.

It can be seen from the above content that the developed modules meet the requirements for higher education under the background of Industry 4.0. There are sufficient students of computer-related majors and various equipment and collected data, which are the embodiment of the sustainability of SHYFTE learning materials. This also laid the foundation for the integration of the new modules into the curriculum.

11. Conclusion

In this work, CUIT and CDU focus on Domain 2 Software Engineer and Big Data Analytics. The modules not only meet the requirements of higher education under the background of industry 4.0, but also focus on many enterprises in the information age. The training of these modules is conducive to cultivating a large number of skilled talents for enterprises, so that the teaching, learning and enterprise requirements of student skills can form a harmonious system.

The first class of each module has been broadcast online, and shyfte partners have participated. And the feedback has been given in the form of questionnaire at the end of each class. The overall improvement actions have divided into two parts: The instruction design element and the content. Regarding the instruction design element, the codes and texts in the word documents that present the experiments are used in different colour and font to improve the legibility. In addition, some mistakes in the PPT and other course materials, such as wrong numbering of the title or example and duplicated sentences, were adjusted to be more appropriate to all the trainee. According to the content of the learning materials, all of the suggestion are about the real example was not sufficient. As a result, the content of the learning materials has added up more examples or showcase which was the case study from the real sector or company. Case studies can run through the whole course content to be better understanding for students.

After developing and revising the learning materials, in view of the COVID situation, the Training of the Trainers is divided into online and offline parts. After the training, CUIT and CDU received the positive feedback, more than 90 percent respondents were interested with the content of the modules. Satisfaction with 17 questions was also above 90 percent. Judging from the student feedback, we should encourage the students to communicate with their teachers in time. At the same time, teachers should also teach in a more specific and appropriate language.

According to experimental results, based on the skills 4.0 framework and the teaching and learning materials defined in the WP2, it can significantly improve the quality of the "Software Engineering and Big Data Analytics" course which required by the companies for the industry of the future.

In the future, we will continue to improve teaching methods and course quality based on existing feedback and subsequent feedback, combined with changes in the times and changing needs of enterprises.

12. Appendix

The papers related to this project published by Chengdu University of Information Technology and Chengdu University are listed below:

[1] Wang, J., Li, D., Zhang, H., Yu, X., Sekhari, A., Ouzrout, Y., & Bouras, A. (2020, February). An Improvement of Support Vector Machine Imputation Algorithm Based on Multiple Iteration and Grid Search Strategies. In 2020 IEEE International Conference on Informatics, IoT, and Enabling Technologies (ICIoT) (pp. 538-543). IEEE.

[2] Li, D., Zhang, H., Li, T., Bouras, A., Yu, X., & Wang, T. (2021). Hybrid missing value imputation algorithms using fuzzy c-means and vaguely quantified rough set. IEEE Transactions on Fuzzy Systems, 30(5), 1396-1408.

[3] Peng, L., Zhang, H., Li, D., Tang, D., Yu, X., & He, L. (2021). Imputation algorithm for hybrid information system of incomplete data analysis approach based on rough set theory. Journal of Computer Applications, 41(3), 677.

[4] You, F., Li, D., Zhang, H., Wang, J., Peng, L., & Wang, Z. (2021). A Random Forest Approach for Missing Data Imputation based on Normalized KNNI. Journal of Chengdu University of Information Technol, 36(1), 9.

[5] Yang, L., Zhang, H., Li, D., Xiao, F., & Yang, S. (2021, September). Facial Expression Recognition Based on Transfer Learning and SVM. In Journal of Physics: Conference Series (Vol. 2025, No. 1, p. 012015). IOP Publishing.

[6] Xiao, F., Zhang, H., Li, D., Yang, L., & Yang, S. (2021). Quantitative evaluation method and empirical study on employability of software engineering graduates in Industry 4.0 environment. Computer Education.

[7] Yang, S., Li, D., Zhang, H., Yang, L., & Xiao, F. Predicting Student Performance by Campus Behaviour Sequences. International Conference on Artificial Intelligence and Computer Science.(To be included in EI)

[8] Yang, M., He, Y., Zhang, H., Li, D., Bouras, A., Yu, X., & Tang, Y. (2019, December). The research on detection of crop diseases ranking based on transfer learning. In 2019 6th International Conference on Information Science and Control Engineering (ICISCE) (pp. 620-624). IEEE.

[9] Yang, M., Li, D., Chen, M., Bouras, A., Tang, Y., & Yu, X. (2020, May). The Implementation of A Crop Diseases APP Based on Deep Transfer Learning. In 2020 3rd International Conference on Artificial Intelligence and Big Data (ICAIBD) (pp. 22-28). IEEE.

[10] Yu, X., Yu, X., Yang, M., Li, R., & Shu, T. (2022). Relationship between target current and wire feeding speed during automatic pipe welding. Welding Technology.

[11] Yu, X., Yang, M., Zhang, H., Li, D., Tang, Y., & Yu, X. (2020). Research and application of crop diseases detection method based on transfer learning. Trans. Chin. Soc. Agricult. Eng., 51(10), 252-258.

[12] Yu, X., Yang, Meng., Yu, X., Liu, Y., Zhao, W., & Nie, L. (2020). Reform and practice of blended teaching of "Object-Oriented Programming" based on network teaching platform. KEXUE ZIXUN.

[13] Duan, Y., Zhao, W., Luo, C., Liu, X., Jiang, H., Tang, Y., ... & Yao, D. (2021). Identifying and Predicting Autism Spectrum Disorder Based on Multi-Site Structural MRI With Machine Learning. Frontiers in human neuroscience, 15.

[14] Song, C., Zhao, W., Jiang, H., Liu, X., Duan, Y., Yu, X., ... & Tang, Y. (2021). Stability Evaluation of Brain Changes in Parkinson's Disease Based on Machine Learning. Frontiers in computational neuroscience, 15.

[15] Zhao, W., Rexma Sherine, V., Gerly, T. G., Britto Antony Xavier, G., Julietraja, K., & Chellamani, P. (2022). Symmetric Difference Operator in Quantum Calculus. Symmetry, 14(7), 1317.

http://www.shyfte.eu/