

**IDENTIFICATION OF STUDENT ACADEMIC PERFORMANCE
IN COMPUTER SCIENCE BASED ON NAÏVE BAYES**

UNDERGRADUATE THESIS

**CREATED BY:
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**JURUSAN TEKNIK INFORMATIKA
FAKULTAS SAINS DAN TEKNOLOGI
UNIVERSITAS ISLAM NEGERI MAULANA MALIK IBRAHIM
MALANG
2020**

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**Diajukan kepada:
Fakultas Sains dan Teknologi
Universitas Islam Negeri Maulana Malik Ibrahim Malang
Untuk Memenuhi Salah Satu Persyaratan Dalam
Memperoleh Gelar Sarjana Komputer (S.Kom)**

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HALAMAN PERSETUJUAN

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Yang membuat
pernyataan,



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KATA PENGANTAR

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Penulis

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ABSTRAK

Aziz, Kevin Elmy. 2020. **Identifikasi Performa Akademik Mahasiswa di dalam Ilmu Komputer berdasarkan Naïve Bayes**. Skripsi. Jurusan Teknik Informatika Fakultas Sains Dan Teknologi Universitas Islam Negeri Maulana Malik Ibrahim Malang.
Pembimbing : (I) Dr. Cahyo Crys dian. (II) M. Imamudin Lc, MA.

Kata Kunci : Klasifikasi, *Preprocessing*, *Naïve Bayes*, *Zeno Dichotomy Paradox*, Performa Akademik.

Jurusan Informatika adalah salah satu program studi di UIN Maulana Malik Ibrahim. Berdasarkan kurikulum saat ini di Jurusan Teknik Informasi, kurikulum mengacu pada Kurikulum *IEEE / ACM Computer Science 2013*. *IEEE / ACM Computer Science 2013* memiliki klasifikasi bidang pengetahuan, yang disebutkan dalam kurikulum memiliki 18 *knowledge area*. Kurikulum yang digunakan dalam program studi saat ini dirumuskan dan ditentukan dari seluruh konten atau kumpulan pengetahuan dalam Kurikulum *IEEE / ACM Computer Science 2013*. Dalam kurikulum Jurusan Teknik Informatika di UIN Malik Ibrahim Malang saat ini terdapat 76 mata kuliah, 58 dari yang merupakan mata pelajaran Teknik Informatika dan 18 lainnya adalah mata pelajaran umum. Untuk mengidentifikasi performa akademik mahasiswa maka perlu dilakukan klasifikasi mata kuliah di kurikulum Jurusan Teknik Informatika terhadap *knowledge area* yang ada di dalam *IEEE/ACM Computer Science Curricula 2013*. Klasifikasi dilakukan dengan menggunakan metode Naïve Bayes dengan menghitung probabilitas setiap mata kuliah terhadap *knowledge area*, setelah dilakukan klasifikasi maka akan muncul data berupa persebaran mata kuliah terhadap *knowledge area*. Setelah dilakukan klasifikasi, maka perlu ditentukan kadar kontribusi dari setiap mata kuliah yang sudah tersebar ke *knowledge area*. Kadar kontribusi ini dimasukkan ke dalam formula Bersama dengan nilai transkrip mahasiswa untuk menghitung performa akademik mahasiswa. Pengujian dilakukan dengan membandingkan output berupa *knowledge area* dengan performa tertinggi yang dihasilkan oleh program dengan input berupa *knowledge area* dari *expert* untuk setiap mahasiswa. Penelitian ini menghasilkan akurasi sebesar 78.95% dari hasil 20 kali percobaan.

ABSTRACT

Aziz, Kevin Elmy. 2020. **Identification of Student Academic Performance in Computer Science based on Naïve Bayes**. Undergraduate thesis. Department of Informatics Engineering, Faculty of Science and Technology, Maulana Malik Ibrahim State Islamic University of Malang.
Supervisor: (I) Dr. Cahyo Crysdian. (II) M. Imamudin Lc, MA.

Keywords: Classification, Preprocessing, Naïve Bayes, Zeno Dichotomy Paradox, Academic Performance.

Jurusan Teknik Informatika is one of the study programs at UIN Maulana Malik Ibrahim. Based on the current curriculum in Jurusan Teknik Informatika, the curriculum refers to the IEEE/ACM Computer Science Curricula 2013. The IEEE/ACM Computer Science Curricula 2013 has a knowledge area classification, which is mentioned in the curriculum as having 18 knowledge areas. The curriculum used in the current technical study program is formulated and determined from the entire content or collection of knowledge in the IEEE/ACM Computer Science Curricula 2013. In the Jurusan Teknik Informatika curriculum at UIN Malik Ibrahim Malang currently there are 76 subjects, 58 of which are Teknik Informatika subjects and 18 others are general subjects. To identify the academic performance of students it is necessary to classify the curriculum in the Department of Informatics Engineering to the knowledge area in the IEEE / ACM Computer Science Curricula 2013. Classification is done using the Naïve Bayes method by calculating the probability of each course of the knowledge area, after it is done classification, data will appear in the form of subject distribution to the knowledge area. After classification, it is necessary to determine the level of contribution of each course that has spread to the knowledge area. This contribution level is entered into the Joint formula with the value of the student transcript to calculate the student's academic performance. Testing is done by comparing the output in the form of knowledge area with the highest performance produced by the program with input in the form of knowledge area from the expert for each student. This research resulted in an accuracy of 78.95% from the results of twenty times experiment

المخلص

عزيز، كفين المي. ٢٠٢٠ تحديد الأداء الأكاديمي للطلاب في علوم الحاسوب استنادا إلى *Naive Bayes*. قسم هندسة المعلوماتية لكلية العلوم والتكنولوجيا في جامعة مولانا مالك إبراهيم الإسلامية الحكومية بمالانج.

المشرف: (١) جاهيو كرسديان، الماجستير. (٢) محمد إمام الدين، الماجستير.

الكلمات الرئيسية: التصنيف، التجهيز المسبق Zeno Dichotomy, Naive Bayes Paradox, الأداء الأكاديمي

وزارة المعلوماتية هي إحدى برامج الدراسة في جامعة الإسلامية الحكومية مولانا مالك إبراهيم. استنادا إلى المنهج الدراسي الحالي في إدارة هندسة المعلومات، يشير المنهج إلى المنهج الدراسي لعلوم الحاسوب IEEE / ACM ٢٠١٣. وقد صنفت العلوم الحاسوبية IEEE / ACM ٢٠١٣ مجال المعرفة، الذي ورد ذكره في المنهج الدراسي له ١٨ مجال معرفي. المنهج المستخدم في الدراسة الحالية البرنامج هو صياغة و تحديد من المحتوى بأكمله أو مجموعة من المعارف في منهاج IEEE / ACM علوم الكمبيوتر ٢٠١٣. ويوجد حاليا في منهج إدارة المعلوماتية في جامعة الإسلامية الحكومية مولانا مالك إبراهيم مالانج ٧٦ مادة، منها ٥٨ مادة من مواد هندسة المعلوماتية و ١٨ مادة أخرى. للتعرف على الأداء الأكاديمي للطلاب فمن الضروري القيام بتصنيف دورات في المناهج الدراسية من قسم المعلوماتية في مجالات المعرفة في IEEE/ACM علوم الكمبيوتر المناهج ٢٠١٣. ويتم التصنيف باستخدام طريقة Naive Bayes لحساب احتمال وصول كل دورة إلى مجال المعرفة، وبعد التصنيف تظهر البيانات في شكل توزيع المواضيع على مجال المعرفة. وبعد التصنيف، من الضروري تحديد مستويات المساهمة في كل دورة من الدورات التي انتشرت إلى مجال المعرفة. وتدرج مستويات هذه المساهمة في الصيغة إلى جانب قيمة محضر الطالب لحساب الأداء الأكاديمي للطلاب. ويجري الاختبار بمقارنة نواتج مجالات المعرفة بأعلى أداء يتمخض عنه البرنامج بمدخلات مجالات المعرفة المتخصصة التي يقدمها الخبير لكل طالب. نتج عن هذا البحث دقة ٩٥.٧٨٪ من نتائج ٢٠ مرة من التجارب

CHAPTER 1

INTRODUCTION

1.1. Research Background

Education is an important aspect of life. The world of education today continues to experience very rapid development. Educational institutions ranging from school to tertiary level also continue to experience growth. College is one of the organizations serving the community in the field of education. To improve the quality of education, technology has become one of the important aspects of improving the quality of education to reach its goals more optimally.

UIN Maulana Malik Ibrahim Malang is one of the universities that uses information systems as a step in technology development. To help run the academic process, UIN Maulana Malik Ibrahim uses information systems as a medium for processing academic-related data.

Jurusan Teknik Informatika is one of the study programs at UIN Maulana Malik Ibrahim. Based on the current curriculum in Jurusan Teknik Informatika, the curriculum refers to the IEEE/ACM Computer Science Curricula 2013. The IEEE/ACM Computer Science Curricula 2013 has a knowledge area classification, which is mentioned in the curriculum as having 18 knowledge areas. The curriculum used in the current technical study program is formulated and determined from the entire content or collection of knowledge in the IEEE/ACM Computer Science Curricula 2013.

In the Jurusan Teknik Informatika curriculum at UIN Malik Ibrahim Malang currently there are 76 subjects, 58 of which are Teknik Informatika subjects and 18 others are general subjects.

Meanwhile, in the IEEE/ACM Computer Science Curricula 2013, 18 knowledge areas are covering the whole topic of the IEEE/ACM Computer Science Curricula 2013, although in fact in IEEE/ACM Computer Science Curricula 2013 it does not confirm or propose a series of subjects or specific curriculum structures. Knowledge areas are not intended to be in a single relationship with certain subjects in the curriculum.

UIN Maulana Malik Ibrahim Malang Teknik Informatika curriculum covers material sourced from the IEEE/ACM Computer Science Curricula 2013 which are packaged into a variety of subjects. At present there is no research and determination raised by the Jurusan Teknik Informatika that discusses the relationship between the subject and the knowledge area, considering that in the IEEE/ACM Computer Science Curricula 2013 there are 18 knowledge areas that can structurally assist in the preparation and grouping of materials for further use as study material in each subject.

شَيْئاً الْحَقِّ مِنْ يُغْنِي لَّا الظَّنَّ وَإِنَّ الظَّنَّ إِلَّا يَتَّبِعُونَ إِنْ عَلِمَ مِنْ بِهِ لَهُمْ وَمَا

“And they don't have any knowledge about it. They are nothing but following the allegation while the truth is that there is no benefit to the truth” (QS. An-Najm : 28)

Based on the above verse, that following the allegation is not allowed. So it needs to be explained that this study aims to determine the academic performance of students based on the existing knowledge area in the IEEE/ACM Computer Science Curricula 2013, by taking transcript scores during their lectures. But before that, it is necessary to classify to determine the relationship between the subject and knowledge area, so that the distribution of subjects will be known to

the knowledge area. At present, there is no grouping or classification of subjects in UIN Maulana Malik Ibrahim's Teknik Informatika curriculum against the knowledge area in IEEE/ACM Computer Science Curricula 2013. To do this classification the Naive Bayes classifier method will be used to determine the distribution of each subject to the knowledge area, this method was chosen because in this classification process the data is in the form of text. As one of these successful methods, Naïve Bayes is popular in text classification due to its computational efficiency and relatively good predictive performance (Chen *et. al*, 2009). In each knowledge area, some topics are set as the focus of the material, while in the subject there are study materials as listed in the semester learning plan or RPS where the study material is the contents of the material in each subject. Then to determine the class or knowledge area that is most suitable for each subject will be classified in the form of text by taking topics from the knowledge area and study material from each subject.

عَلَىٰ وَفَضَّلْنَاهُمْ الطَّيِّبَاتِ مِّنْ وَرَزَقْنَاهُمْ وَالْبَحْرِ الْبَرِّ فِي وَحَمَلْنَاهُمْ أَدَمَ بَيْتِي كَرَمًا وَلَقَدْ
تَفْضِيلًا خَلَقْنَا مِمَّنْ كَثِيرٍ

“And indeed, We have glorified Adam's children and grandchildren, and We transported them on land and on the sea, and We gave them sustenance from the good and We exaggerated them above the many creatures We created with perfect advantages.” (QS. Al-Isro : 70)

The above verse explains that every human being at birth has been given an advantage over other creatures created by God. One of those strengths is talent. In this study, the output produced from this application is the academic performance

of students following the existing knowledge area in the IEEE/ACM Computer Science Curricula 2013.

In determining student academic performance, student value transcripts will be used as a reference in determining academic performance by calculating the value of each subject that has been classified into the knowledge area. After going through the calculation process, the output of this application is the value of each knowledge area, to determine the academic performance can be known by seeing the knowledge area with the highest value.

1.2. Research Question

How accurate are Naive Bayes and Zeno Dichotomy Paradox to identify student academic performance based on student transcript scores?

1.3. Research Objective

To measure the accuracy of Naïve Bayes and Zeno Dichotomy Paradox for identifying student academic performance based on student transcript scores.

1.4. Research Scope

1. This study focuses on the classification of subjects in the knowledge area of IEEE/ACM Computer Science Curricula 2013 by taking study material from the semester learning plan and topics from the knowledge area.
2. The data of curriculum is obtained from Jurusan Teknik Informatika of UIN Maulana Malik Ibrahim Malang, which is currently active and the IEEE/ACM Computer Science Curricula 2013.
3. Student grade transcript used is the 7th-semester student transcript with a total of 20 student transcripts.

1.5. Research Benefit

The results of this research are expected to provide the following benefits :

1. To facilitate study programs to analyze the distribution of subjects to the knowledge area based on the study material in the subject.
2. To facilitate students to identify student academic performance based on student transcript scores.



CHAPTER 2

LITERATURE REVIEW

Related research conducted by Jiang take the first step by review the existing weighting approach for Naive Bayes and find that all of them only include the weight of the features studied in the classification of Naïve Bayes formulas and in no way include the weight of the features learned into estimation of conditional probabilities at all. Then, the researcher proposed a simple, efficient, and effective feature weight approach, called deep feature weighting (DFW), which estimates the conditional probabilities of Naive Bayes by calculating the frequency of feature weighted frequencies from the training data (Jiang *et. al*, 2016).

Alkubaisi *et. al* (2018) did a research and showed that their research has achieved high accuracy equal to 90.38% for HNBC with all classes (positive, negative and neutral). This result will enable decision-makers and investors in the domain of the stock market exchange to make safe, low-risk decisions because these results depend on facts about the stock market domain. Facts such as spatial and temporal features are needed in addition to the role of stock market experts in achieving real sentiment analysis. High classification accuracy with real sentiment analysis will produce reports and indicators that are accurate and reliable on company shares. from these results, it can be seen that machine learning methods that use sentiment analysis on Twitter such as the NB classifier produce high, real and reliable accuracy by simulating domain features and preparing datasets using the NLP method. In other research, Naive Bayes with the Query Expansion Ranking feature selection to reduce the number of features in the classification process. The process of sentiment analysis consists of preprocessing, feature selection using the

Expansion Ranking Query method, and classification with Naive Bayes. The test in this study is an accuracy test using variations in the ratio of feature selection, the result is feature selection 75% has the best accuracy of 86.6% (Fanissa *et. al*, 2018).

Indrayuni (2019) researched and proved that based on testing the model using the Naive Bayes algorithm in experiments that have been carried out it is proven that the Naive Bayes algorithm is the simplest algorithm which is proven to produce high accuracy values up to 90.50% with an AUC value of 0.715.

Other studies regarding the comparison of methods in classification are carried out for personality classification. Testing was conducted using 10-fold cross-validations. In the crossvalidation testing, MNB got the best accuracy in three methods tested with average accuracy 60%. SVM and KNN performed similarly. SVM method performs worse than MNB due to difficulties separating a class of a word as dataset are not quite accurate. KNN method also performs worse than MNB. The alleged cause of the low accuracy of the KNN method because of the difficulty in determining the optimal value of K. Total value of K is crucial because the KNN's probability result will be calculated from the K samples. This is different from MNB that uses pure probability calculations on existing features. Based on macro-averaged scores in 59%-60%, this experiment fails to improve accuracy, as it is only equal to the best score from previous research (61%) (Pratama and Sarno, 2016).

In contrast to the above research, this study does not use initial data that already labeled like other research that already have data with labels that have been determined, in this study the amount of data will be the same as the number of courses and the data will be formed from terms that arise from each course with a

class contains 18 knowledge areas. Then the level of contribution of each course will be determined to the knowledge area using the concept of the Zeno dichotomy paradox. After that, the last stage is the process of determining student academic performance will be used a transcript of student scores as input and the proposed formula regarding the distribution of courses in each knowledge area.



CHAPTER 3

SYSTEM DESIGN AND IMPLEMENTATION

3.1. System Design

The System design is shown in Figure 3.1 which consists of some steps, namely dataset, preprocess, Naïve Bayes, Zeno Dichotomy Paradox, transcript score input, subject and score distribution, knowledge area performance and highest score of knowledge area. The next steps will be discussed in the next session.

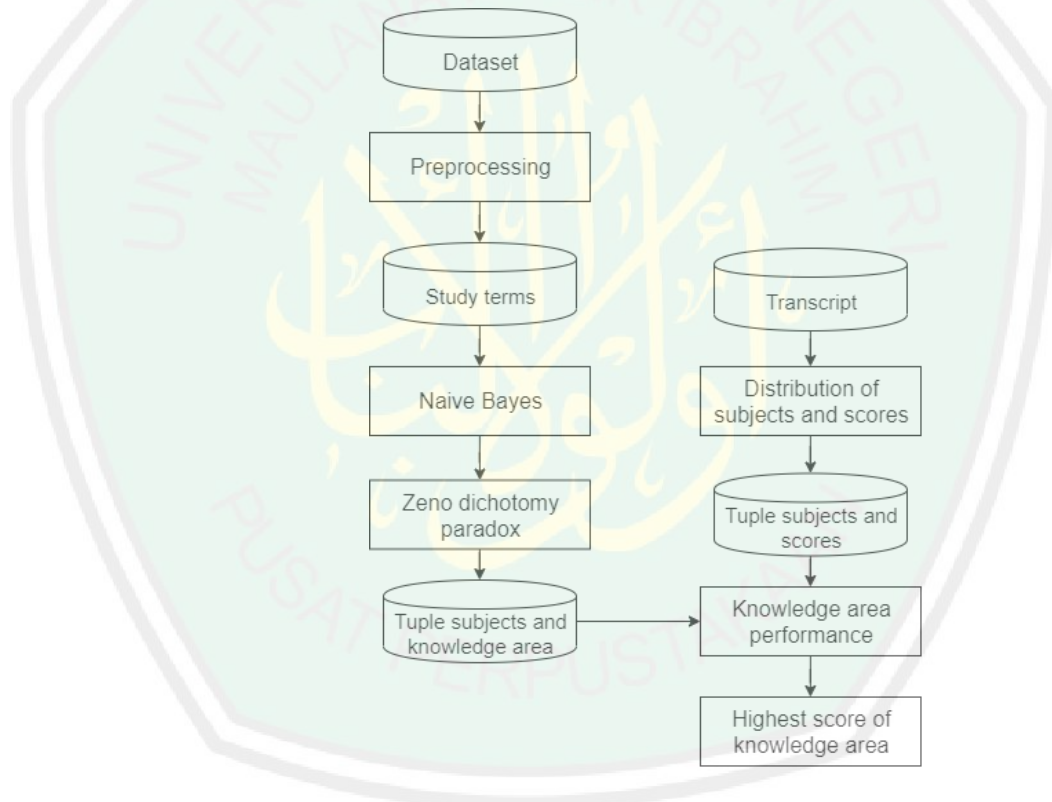


Figure 3.1 System Design

3.1.1. Dataset

Data is in form of text and numeric, taken from the RPS document which is a semester learning plan in the jurusan Teknik informatika, knowledge area in the

IEEE/ACM Computer Science Curricula 2013, and student score transcripts as in Figure 3.2.

Subjects	Knowledge Area	Transcripts
id name sks topics	id code name topics	id name sks score

Figure 3.2 Dataset

One of the data to be used comes from the study material contained in the RPS document. Study material contains a collection of terms about what is to be taught in the subject. The study material in the RPS document as shown in Figure 3.3 below.

A. RENCANA PEMBELAJARAN SEMESTER (RPS) BERDASARKAN PERMENRISTEKDIKTI NO. 44/2015 SNPT PASAL 12

RENCANA PEMBELAJARAN SEMESTER

MATA KULIAH : WEB PROGRAMMING + PRACTICUM
 SKS : 3+1
 KODE : 1565014 + 1565038
 PROGRAM STUDI : TEKNIK INFORMATIKA
 SEMESTER : 4
 NAMA DOSEN PENGAMPU :
 COURSE LEARNING OUTCOMES : 1. Students are able to explain the concept of web technology & web application.
 (Capaian Pembelajaran Mata Kuliah) : 2. Students are able to build & develop active web application.

Minggu Ke-	Kemampuan yang Diharapkan pada Setiap Pertemuan	Bahan Kajian	Metode Pembelajaran	Waktu Belajar (Menit)	Pengalaman Belajar Mahasiswa (Deskripsi Tugas)	Kriteria, Indikator dan Bobot Penilaian	Daftar Referensi yang digunakan
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ke-1	Mampu memahami, menjelaskan dan mengimplementasikan konsep HTML	HTML	Pertemuan di kelas dan praktek	3 x 50 menit dan 1x 100 menit	Memahami, menjelaskan dan mengimplementasikan konsep HTML	6.25 %	
Ke-2	Mampu memahami, menjelaskan dan mengimplementasikan konsep HTML	HTML	Pertemuan di kelas dan praktek	3 x 50 menit dan 1x 100 menit	Memahami, menjelaskan dan mengimplementasikan konsep HTML	6.25 %	
Ke-3	Mampu memahami, menjelaskan dan mengimplementasikan konsep XML	XML	Pertemuan di kelas dan praktek	3 x 50 menit dan 1x 100 menit	Memahami, menjelaskan dan mengimplementasikan konsep XML	6.25 %	
Ke-4	Mampu memahami, menjelaskan dan mengimplementasikan konsep XML	XML	Pertemuan di kelas dan praktek	3 x 50 menit dan 1x 100 menit	Memahami, menjelaskan dan mengimplementasikan konsep XML	6.25 %	
Ke-5	Mampu memahami, menjelaskan dan mengimplementasikan konsep CSS.	CSS.	Pertemuan di kelas dan praktek	3 x 50 menit dan 1x 100 menit	Memahami, menjelaskan dan mengimplementasikan konsep CSS.	6.25 %	
Ke-6	Mampu memahami, menjelaskan dan mengimplementasikan	CSS.	Pertemuan di kelas dan praktek	3 x 50 menit dan 1x 100 menit	Memahami, menjelaskan dan mengimplementasikan konsep CSS.	6.25 %	

Figure 3.3 Study material contained in the RPS document

The next data that will be used is the topic of the existing knowledge area in the IEEE/ACM Computer Science Curricula 2013. The topic in this knowledge area contains a collection of terms forming a study material. The topic of the knowledge area is shown in Figure 3.4.

AI/Basic Analysis**[2 Core-Tier1 hours, 2 Core-Tier2 hours]****Topics:****[Core-Tier1]**

- Differences among best, expected, and worst case behaviors of an algorithm
- Asymptotic analysis of upper and expected complexity bounds
- Big O notation: formal definition
- Complexity classes, such as constant, logarithmic, linear, quadratic, and exponential
- Empirical measurements of performance
- Time and space trade-offs in algorithms

[Core-Tier2]

- Big O notation: use
- Little o, big omega and big theta notation
- Recurrence relations
- Analysis of iterative and recursive algorithms
- Some version of a Master Theorem

AI/Fundamental Data Structures and Algorithms**[9 Core-Tier1 hours, 3 Core-Tier2 hours]**

This knowledge unit builds directly on the foundation provided by Software Development Fundamentals (SDF), particularly the material in SDF/Fundamental Data Structures and SDF/Algorithms and Design.

Topics:**[Core-Tier1]**

- Simple numerical algorithms, such as computing the average of a list of numbers, finding the min, max, and mode in a list, approximating the square root of a number, or finding the greatest common divisor
- Sequential and binary search algorithms
- Worst case quadratic sorting algorithms (selection, insertion)
- Worst or average case $O(N \log N)$ sorting algorithms (quicksort, heapsort, mergesort)
- Hash tables, including strategies for avoiding and resolving collisions
- Binary search trees
 - Common operations on binary search trees such as select min, max, insert, delete, iterate over tree
- Graphs and graph algorithms
 - Representations of graphs (e.g., adjacency list, adjacency matrix)
 - Depth- and breadth-first traversals
- Heaps
- Graphs and graph algorithms
 - Shortest-path algorithms (Dijkstra's and Floyd's algorithms)
 - Minimum spanning tree (Prim's and Kruskal's algorithms)
- Pattern matching and string-text algorithms (e.g., substring matching, regular expression matching, longest common subsequence algorithms)

[Core-Tier2]

- Heaps
- Graphs and graph algorithms
 - Shortest-path algorithms (Dijkstra's and Floyd's algorithms)
 - Minimum spanning tree (Prim's and Kruskal's algorithms)
- Pattern matching and string-text algorithms (e.g., substring matching, regular expression matching, longest common subsequence algorithms)

DS/Sets, Relations, and Functions**[4 Core-Tier1 hours]****Topics:**

- Sets
 - Venn diagrams
 - Union, intersection, complement
 - Cartesian product
 - Power sets
 - Cardinality of finite sets
- Relations
 - Reflexivity, symmetry, transitivity
 - Equivalence relations, partial orders
- Functions
 - Surjections, injections, bijections
 - Inverses
 - Composition

GV/Basic Rendering**[Elective]**

This section describes basic rendering and fundamental graphics techniques that nearly every undergraduate course in graphics will cover and that are essential for further study in graphics. Sampling and anti-aliasing are related to the effect of digitization and appear in other areas of computing, for example, in audio sampling.

Topics:

- Rendering in nature, e.g., the emission and scattering of light and its relation to numerical integration
- Forward and backward rendering (i.e., ray-casting and rasterization)
- Polygonal representation
- Basic radiometry, similar triangles, and projection model
- Affine and coordinate system transformations
- Ray tracing
- Visibility and occlusion, including solutions to this problem such as depth buffering, Painter's algorithm, and ray tracing
- The forward and backward rendering equation
- Simple triangle rasterization
- Rendering with a shader-based API
- Texture mapping, including minification and magnification (e.g., trilinear MIP-mapping)
- Application of spatial data structures to rendering
- Sampling and anti-aliasing
- Scene graphs and the graphics pipeline

IS/Fundamental Issues**[1 Core-Tier2 hours]****Topics:**

- Overview of AI problems, examples of successful recent AI applications
- What is intelligent behavior?
 - The Turing test
 - Rational versus non-rational reasoning
- Problem characteristics
 - Fully versus partially observable
 - Single versus multi-agent
 - Deterministic versus stochastic
 - Static versus dynamic
 - Discrete versus continuous
- Nature of agents
 - Autonomous versus semi-autonomous
 - Reflexive, goal-based, and utility-based
 - The importance of perception and environmental interactions
- Philosophical and ethical issues. [elective]

IAS/Cryptography**[1 Core-Tier2 hour]****Topics:****[Core-Tier2]**

- Basic Cryptography Terminology covering notions pertaining to the different (communication) partners, secure/unsecure channel, attackers and their capabilities, encryption, decryption, keys and their characteristics, signatures
- Cipher types (e.g., Caesar cipher, affine cipher) together with typical attack methods such as frequency analysis
- Public Key Infrastructure support for digital signature and encryption and its challenges

[Elective]

- Mathematical Preliminaries essential for cryptography, including topics in linear algebra, number theory, probability theory, and statistics
- Cryptographic primitives:
 - pseudo-random generators and stream ciphers
 - block ciphers (pseudo-random permutations), e.g., AES
 - pseudo-random functions
 - hash functions, e.g., SHA2, collision resistance
 - message authentication codes
 - key derivations functions
- Symmetric key cryptography:
 - Perfect secrecy and the one time pad
 - Modes of operation for semantic security and authenticated encryption (e.g., encrypt-then-MAC, OCB, GCM)
 - Message integrity (e.g., CMAC, HMAC)
- Public key cryptography:
 - Trapdoor permutation, e.g., RSA
 - Public key encryption, e.g., RSA encryption, El Gamal encryption
 - Digital signatures
 - Public-key infrastructure (PKI) and certificates
 - Hardness assumptions, e.g., Diffie-Hellman, integer factoring
- Authenticated key exchange protocols, e.g., TLS
- Cryptographic protocols: challenge-response authentication, zero-knowledge protocols, commitment, oblivious transfer, secure 2-party or multi-party computation, secret sharing, and applications
- Motivate concepts using real-world applications, e.g., electronic cash, secure channels between clients and servers, secure electronic mail, entity authentication, device pairing, voting systems.
- Security definitions and attacks on cryptographic primitives:
 - Goals: indistinguishability, unforgeability, collision-resistance
 - Attacker capabilities: chosen-message attack (for signatures), birthday attacks, side channel attacks, fault injection attacks.
- Cryptographic standards and references implementations
- Quantum cryptography

GV/Visualization**[Elective]**

Visualization has strong ties to the Human-Computer Interaction (HCI) knowledge area as well as Computational Science (CN). Readers should refer to the HCI and CN KAs for additional topics related to user population and interface evaluations.

Topics:

- Visualization of 2D/3D scalar fields: color mapping, isosurfaces
- Direct volume data rendering: ray-casting, transfer functions, segmentation
- Visualization of:
 - Vector fields and flow data
 - Time-varying data
 - High-dimensional data: dimension reduction, parallel coordinates,
 - Non-spatial data: multi-variate, tree/graph structured, text
- Perceptual and cognitive foundations that drive visual abstractions
- Visualization design
- Evaluation of visualization methods
- Applications of visualization

CN/Processing**[Elective]**

The processing topic area includes numerous topics from other knowledge areas. Specifically, coverage of processing should include a discussion of hardware architectures, including parallel systems, memory hierarchies, and interconnections among processors. These are covered in AR/Interfacing and Communication, AR/Multiprocessing and Alternative Architectures, AR/Performance Enhancements.

Topics:

- Fundamental programming concepts:
 - The concept of an algorithm consisting of a finite number of well-defined steps, each of which completes in a finite amount of time, as does the entire process.
 - Examples of well-known algorithms such as sorting and searching.
 - The concept of analysis as understanding what the problem is really asking, how a problem can be approached using an algorithm, and how information is represented so that a machine can process it.
 - The development or identification of a workflow.
 - The process of converting an algorithm to machine-executable code.
 - Software processes including lifecycle models, requirements, design, implementation, verification and maintenance.
 - Machine representation of data computer arithmetic.
- Numerical methods
 - Algorithms for numerically fitting data (e.g., Newton's method)
 - Architectures for numerical computation, including parallel architectures
- Fundamental properties of parallel and distributed computation:
 - Bandwidth.
 - Latency.
 - Scalability.
 - Granularity.
 - Parallelism including task, data, and event parallelism.
 - Parallel architectures including processor architectures, memory and caching.
 - Parallel programming paradigms including threading, message passing, event driven techniques, parallel software architectures, and MapReduce.
 - Grid computing.
 - The impact of architecture on computational time.
 - Total time to science cost for parallelism: continuum of things.
- Computing costs, e.g., the cost of re-computing a value vs. the cost of storing and lookup.

IS/Basic Knowledge Representation and Reasoning**[3 Core-Tier2 hours]****Topics:**

- Review of propositional and predicate logic (cross-reference DS/Basic Logic)
- Resolution and theorem proving (propositional logic only)
- Forward chaining, backward chaining
- Review of probabilistic reasoning, Bayes theorem (cross-reference with DS/Discrete Probability)

Figure 3.4 Topics contained in the knowledge area of IEEE/ACM Computer Science Curricula 2013

In total there are 18 knowledge areas as shown in Table 3.1. each knowledge area has chapters, within each chapter there is a topic that contains a collection of terms. a list of knowledge areas and courses and a list of terms that are in the knowledge area and courses can be seen in Appendix 1.

3.1.2. Preprocessing

Each subject and knowledge area will be preprocessed, the preprocessing stage covers some stages including, case folding, tokenizing and stopword removal. Case folding is the process of turning all characters into standard shapes, in this study all characters will be converted to lowercase letters. For example, the word "binary" if the word is at the beginning of a sentence from the topic it will have capital letters as its first character, and when compared with the same word but do not have capital letters the system will be considered a different string because the string has case sensitive properties. So it is necessary to do a folding case so that all words that are visibly the same but have different character structures will be considered the same again because the form has been changed to a similar form.

Then after doing a case folding, the tokenizing process will be carried out, namely breaking the string into single words. Topics formed from many sentences will be broken down into a collection of single words and remove punctuation and spaces. This process is carried out to make it easier to calculate the frequency of appearance of the term during the training data formation stage.

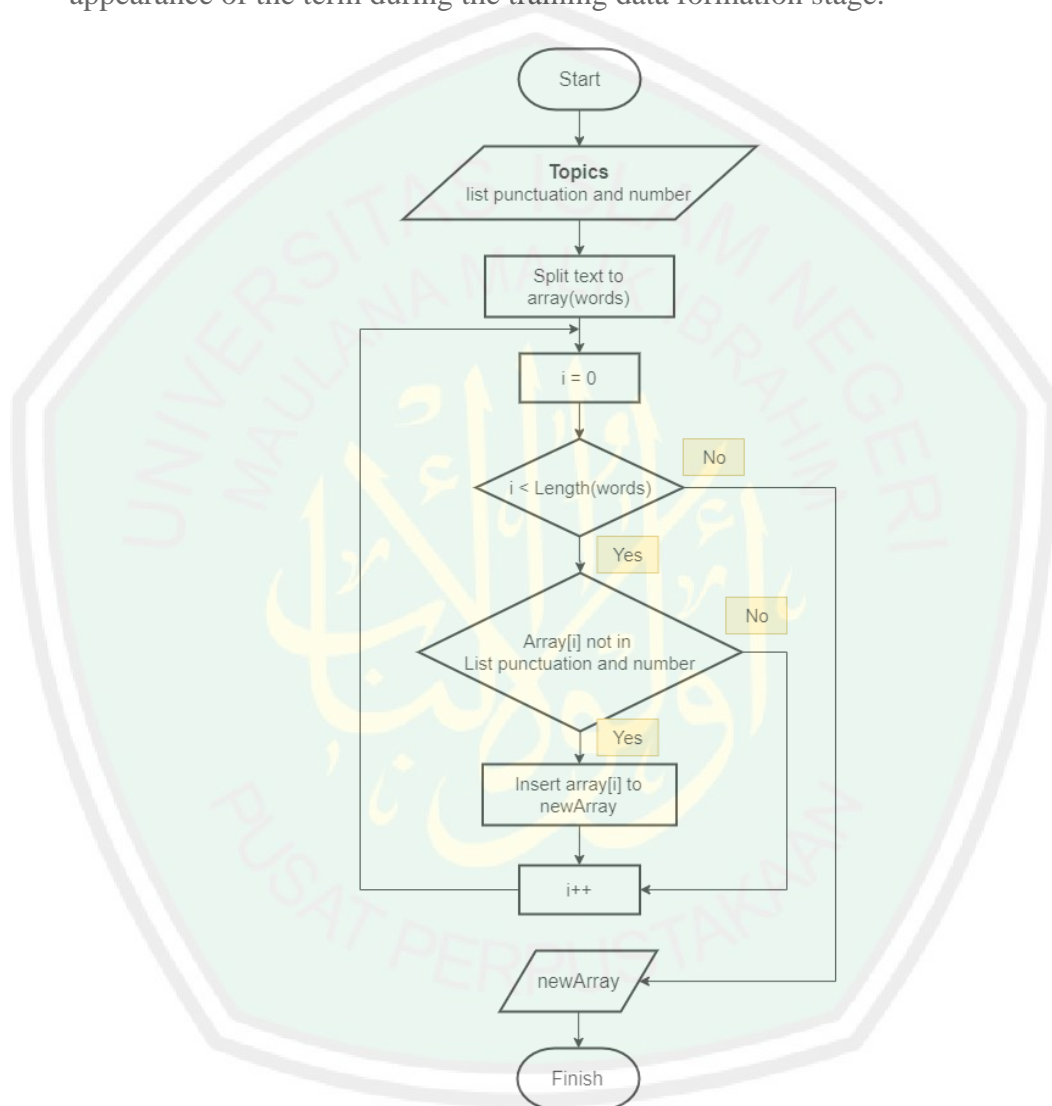


Figure 3.7 Flowchart Tokenizing

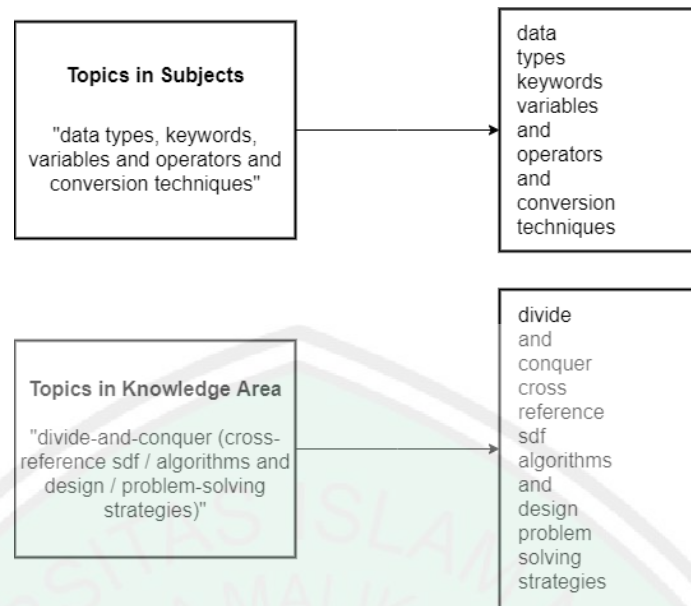


Figure 3.8 Output Tokenizing

The final step of the preprocessing stage is stopwords removal, which is to discard words that are considered to have no meaning, usually conjunctions, or common words that have no meaningful value. Following the stopwords removal flowchart in Figure 3.9 and the output of stopwords removal is shown in Figure 3.10.

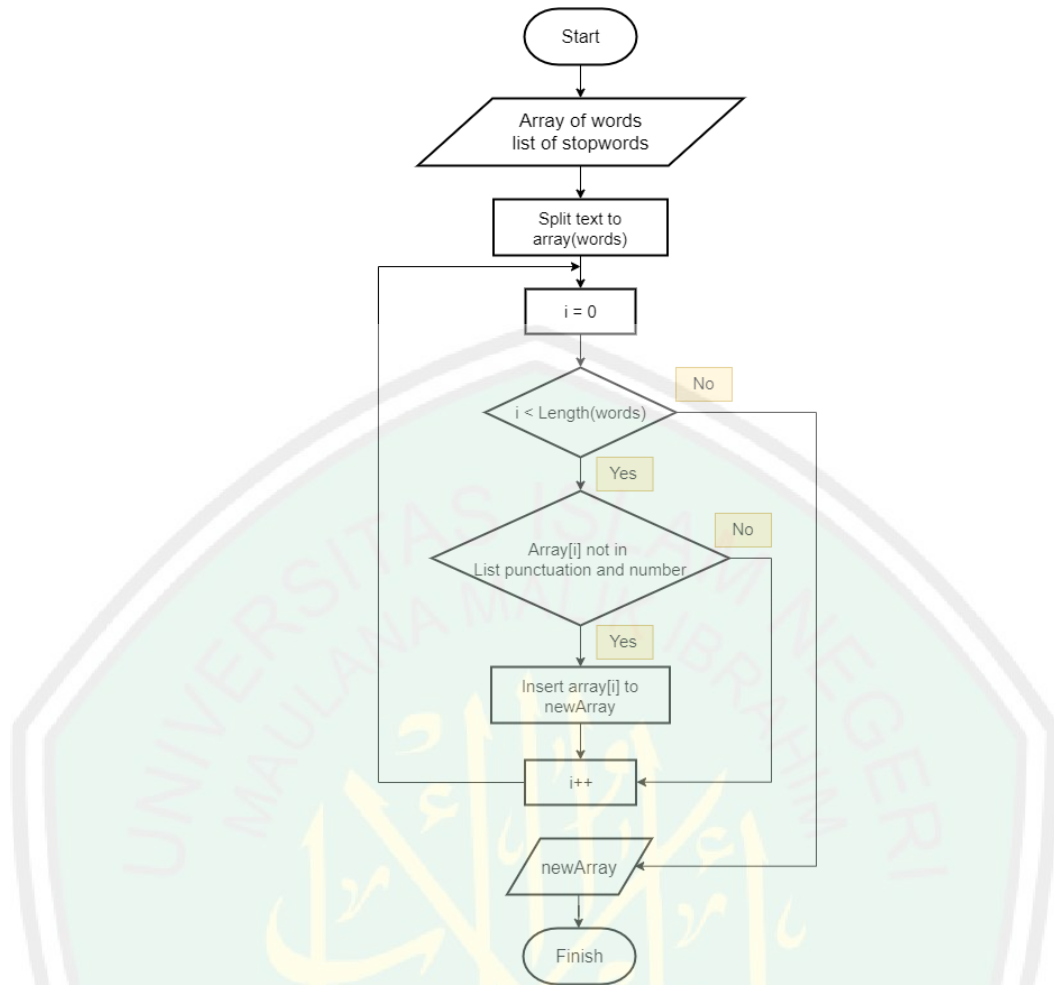


Figure 3.9 Flowchart Stopwords Removal

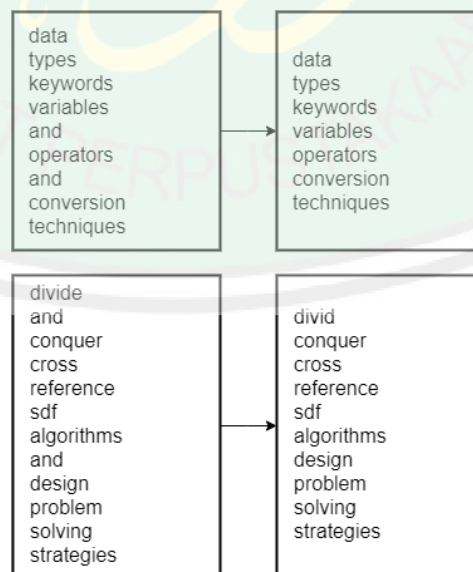


Figure 3.10 Output Stopwords Removal

3.1.3. Study terms

Then by using study material from subjects and topics from the knowledge area, it will form data such as the Table 3.1 below, as in Appendix 1 the example table below shows the data generated from Web Programming subjects on the knowledge area.



Table 3.1 Subject terms – Web Programming

Knowledge Area (Class)	html	xml	css	php	java	script	framework
AL - Algorithms and Complexity	0	0	0	0	0	0	0
AR - Architecture and Organization	0	0	0	0	0	0	0
CN - Computational Science	0	0	0	0	0	0	0
DS - Discrete Structures	0	0	0	0	0	0	0
GV - Graphics and Visualization	0	0	0	0	0	0	0
HCI - Human-Computer Interaction	0	0	0	0	0	0	0
IAS - Information Assurance and Security	0	0	0	0	0	0	0
IM - Information Management	0	1	0	0	0	0	0
IS - Intelligent Systems	0	0	0	0	0	0	0
NC - Networking and Communications	0	0	0	0	0	0	0
OS - Operating Systems	0	0	0	0	0	0	0
PBD - Platform-based Development	0	0	1	1	1	1	0
PD - Parallel and Distributed Computing	0	0	0	0	0	0	0
PL - Programming Languages	0	0	0	0	0	0	0
SDF - Software Development Fundamental	0	0	0	0	0	0	0
SE - Software Engineering	0	0	0	0	0	0	0
SF - Systems Fundamentals	0	0	0	0	0	0	0
SP - Social Issues and Professional Practice	0	0	0	0	0	0	0

3.1.4. Naïve Bayes

Naive Bayes Classifier is a popular algorithm used for data mining purposes because of its ease of use and fast processing time, easy to implement with a fairly simple structure and high level of effectiveness (Taheri & Mammadov, 2013).

The difference between Naïve Bayes classifiers and other learning methods lies in the process of developing hypotheses. In the Naïve Bayes classifier, a hypothesis is formed directly without a search process, only by calculating the frequency of occurrence of a word in the training data, whereas in other learning methods a hypothesized search is usually performed from the hypothesis space.

Naive Bayes equation, in general, can be written as follows.

$$P(C|X) = \frac{P(x|c)P(c)}{P(x)} \quad (3.1)$$

Naive Bayes equation, in general, can Further elaboration of the Bayes formula is done by describing $(c | x_1, \dots, x_n)$, then the following equation applies written as follows.

$$P(c|X) = P(x_1|c)P(x_2|c)P(x_3|c) \dots P(x_n|c)P(c) \quad (3.2)$$

In this stage the results will be obtained is the subject classification of the knowledge area by taking the highest probability of each knowledge area. In general, the implementation of the Naïve Bayes method algorithm in this study can be explained in the form of a flowchart as shown in Figure 3.11.

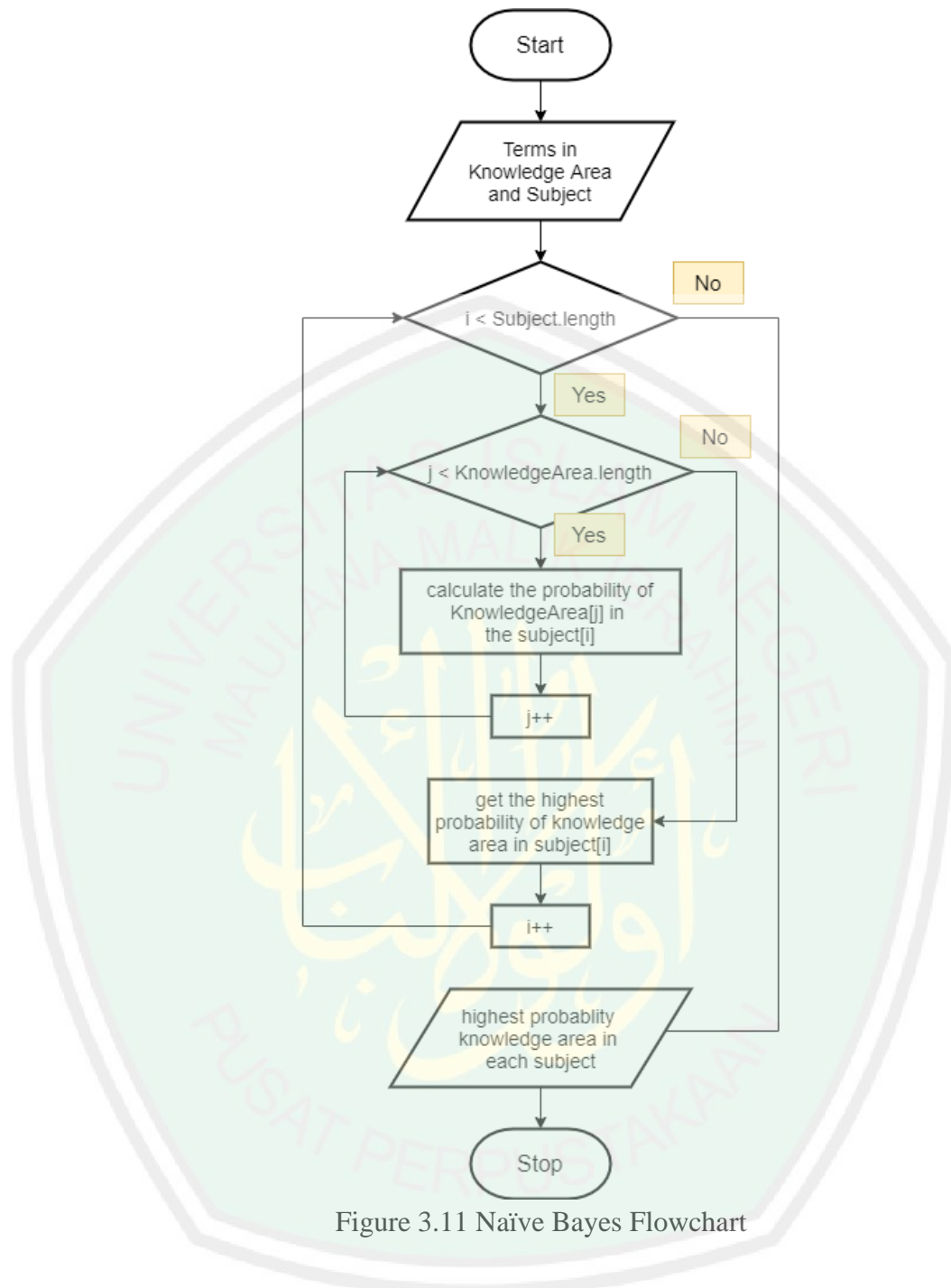


Figure 3.11 Naïve Bayes Flowchart

In the calculation phase using the Naïve Bayes method, the probability sought is the probability of each knowledge area for a subject to find out which subject belongs to the knowledge area, by ranking the knowledge area based on the highest probability using the following formula.

$$P(KA|Subject(terms)) = P(html|KA)P(xml|KA)P(css|KA) \dots P(framework|KA)P(KA)$$

Naive Bayes formula above can bring up the possibility there will be a probability of 0 because there may be a knowledge area that has absolutely no term in the subject matter of a course. Therefore, efforts should be made to avoid the 0 probability. The method that can be used to avoid this is to use laplace correction.

$$\rho_i = \frac{m_i+1}{n+k} \quad (3.3)$$

After the probability value of each knowledge area is obtained, then the next step is the sorting stage, that is, the knowledge area will be sorted based on the probability value from highest to lowest and then proceed to the next stage, namely determining the value of the subject contribution to each knowledge area.

3.1.5. Zeno Dichotomy Paradox

Zeno Dichotomy Paradox is used to determine the weights of the size of features that are not fixed (Crysdian, 2017). The weights assigned to each feature size follow the famous paradoxical Zeno Dichotomy series.

In this paradox, it is explained that in order to achieve a goal, a person must take a segment halfway, and after that to get through the next segment a person must still go through more segments including a quarter, eighth, sixteen and so on.

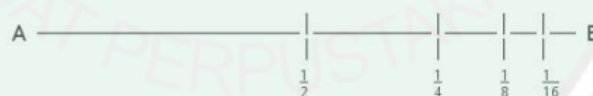


Figure 3.12 Zeno Dichotomy Paradox

From Figure 3.12 it can be seen that in traveling a distance, each trip will take one segment in advance which segment is half of the journey of one segment. Following the concept of Zeno Dichotomy Paradox, this research will apply the concept of this paradox in determining the value of the contribution of each subject to a knowledge area like in the example in Figure 3.13 below.

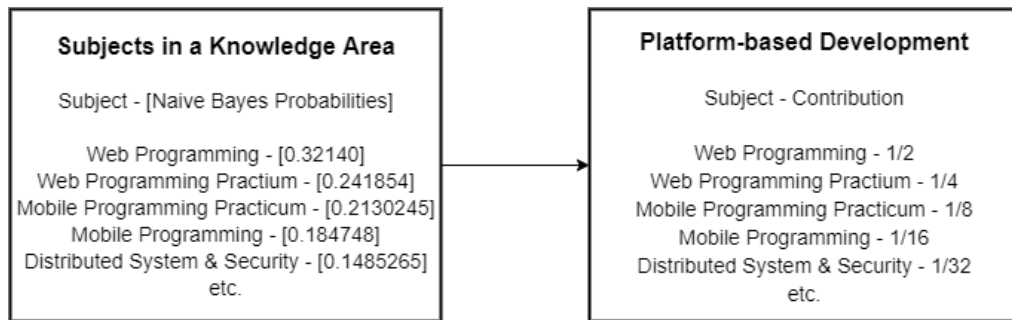


Figure 3.13 Subjects Contribution to The Knowledge Area

3.1.6. Input Transcript

The input transcript value of students is done by entering the transcript value file with excel format into the system to then be converted to an array of objects. Then from the value data will be entered into the structure of the object array that contains the contribution of subjects to each knowledge area. The object generated from the excel input file is as shown in Figure 3.14 below.

Platform-based Development

Subject
[Score] - [SKS] - [Contribution]

Web Programming
[A] - [3] - [1/2]

Web Programming Practicum
[B] - [1] - [1/4]

Mobile Programming Practicum
[B] - [1] - [1/8]

Mobile Programming
[A] - [3] - [1/16]

Distributed System & Security
[A] - [3] - [1/32]

etc.

Figure 3.14 List of Subject inside Knowledge Area after Input Scores

3.1.7. Knowledge area performance

Knowledge area performance calculation is done by the proposed formula used to get the final value of each knowledge area, where each knowledge area has many subjects and each level contributes.

$$KA_i = \frac{\sum_{j=1}^n (score_j * sks_j * contribution_j)}{\sum_{j=1}^n (sks_j)} \quad (3.4)$$

In the equation above, to calculate the final value of each knowledge area, 18-times repetition or several existing knowledge areas will be repeated. Then in each iteration, there will be repeated to get the total value or score and the total of credits. Repetition in each knowledge area will be carried out several times according to the number of subjects in the knowledge area.

3.2. Implementation

The implementation is based on the steps mentioned earlier in sub-chapter 3. Besides, this web-based application has a user interface and the user interface will be displayed at each stage of this implementation to display the results of each process.

3.2.1. Dataset

The first stage is collecting data and displaying it to the application to see the initial data that will be processed by this application. The initial data is in the form of text, namely the study material in the RPS document and the topics in the Knowledge Area. Next is the main page display of the application along with an overview for the initial data.

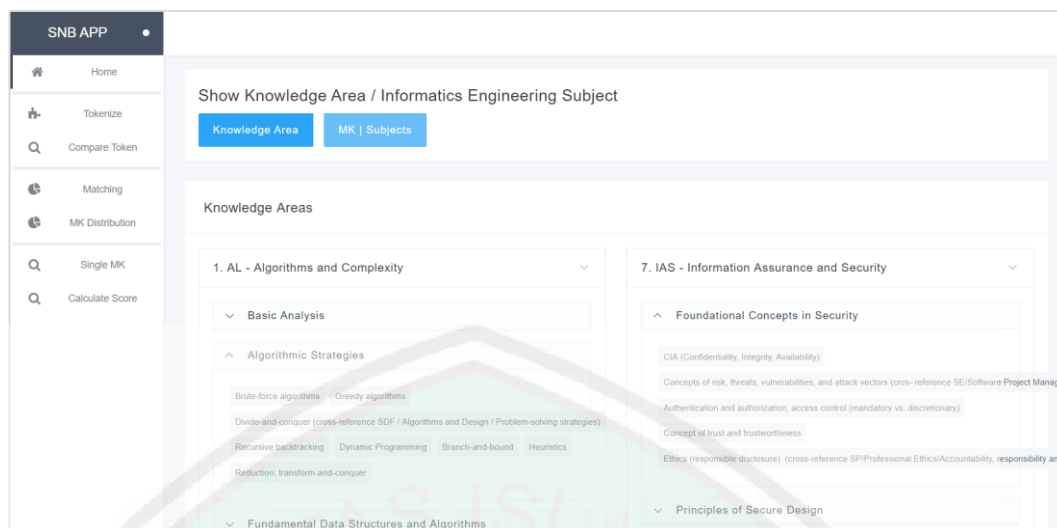


Figure 3.15 Homepage – Topics in Knowledge Area



Figure 3.16 Homepage – Study Material in Subject

In Figure 3.15 above, you can see preliminary data from topics in the knowledge area, in the form of sentence descriptions about the topics in each knowledge area.

3.2.2. Preprocessing

Preprocessing has three stages including, case folding, tokenizing, and stopword removal. In this system, the case folding and stopwords removal process is carried out in the middle of the tokenizing process. This is done to reduce the

number of loops in the program because looping to tokenize is done to the level per word making it possible to do the case folding process as well as the stopwords removal process, ie checking whether the word entered into the list of words that must be removed. Here is the source code for the Knowledge Area data preprocessing process.

```
function dataKaTokenize() {
  for (var i = 0; i < dataKa.length; i++) {
    // KA array structure
    var kaObj = {}
    kaObj['id'] = dataKa[i].id
    kaObj['area_code'] = dataKa[i].area_code
    kaObj['knowledge_area'] = dataKa[i].knowledge_area
    kaObj['chapters'] = []
    // [revision] ignore chapter
    var kaTokenized = []
    // loop chapter
    for (var j = 0; j < dataKa[i].chapters.length; j++) {
      var kaChapterObj = {}
      kaChapterObj['chapter'] = dataKa[i].chapters[j].chapter
      var combinedTopics = []
      // loop topics
      for (var k = 0; k < dataKa[i].chapters[j].topics.length; k++) {
        var tokenized = tokenizer.tokenize(dataKa[i].chapters[j].topics[k]);
        for (var l = 0; l < tokenized.length; l++) {
          // case folding
          if(kaTokenized.length == 0){
            kaTokenized.push(tokenized[l].toLowerCase())
          }
          else {
            // check if terms already exist / added
            var isDuplicated = false
            for (var m = 0; m < kaTokenized.length; m++) {
              if(kaTokenized[m] == tokenized[l].toLowerCase()){
                isDuplicated = true
                break
              }
            }
            if(isDuplicated == false) {
              // stopwords (ignore term included in stopword)
              var isIgnored = false
              for (var n = 0; n < ignoredToken.length; n++) {
                if ( tokenized[l].toLowerCase() == ignoredToken[n] ){
                  isIgnored = true
                  break
                }
              }
              if(!isIgnored){
                combinedTopics.push(tokenized[l].toLowerCase())
                kaTokenized.push(tokenized[l].toLowerCase())
              }
            }
          }
        }
      }
    }
  }
}
```

```

    }
  }
}
kaChapterObj['tokenized'] = kaTokenized
kaObj['chapters'].push(kaChapterObj)
}
kaObj['tokenized'] = kaTokenized
kaToken.push(kaObj)
}
}
}

```

Figure 3.17 Source Code Preprocessing for Knowledge Area

Next is the appearance of the tokenize page that contains data after preprocessing includes tokenizing, case folding and stopwords removal.

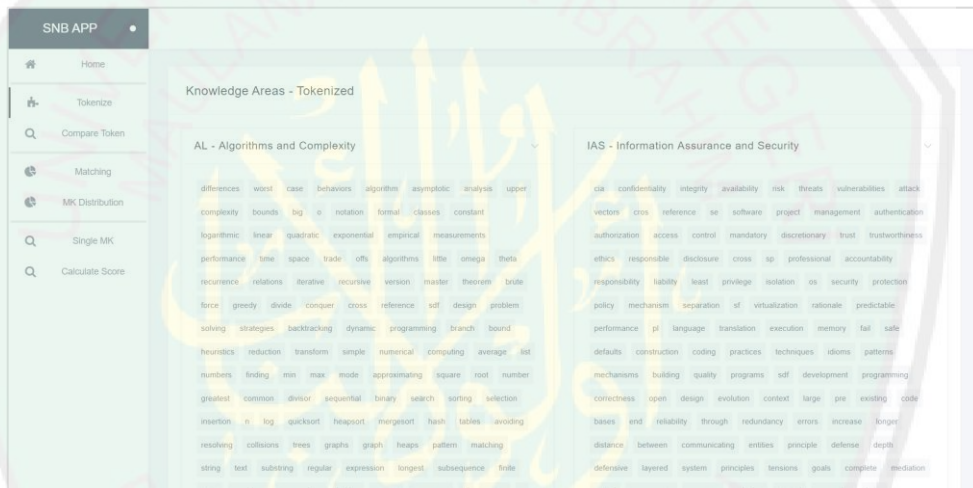


Figure 3.18 Tokenized Page - Knowledge Area

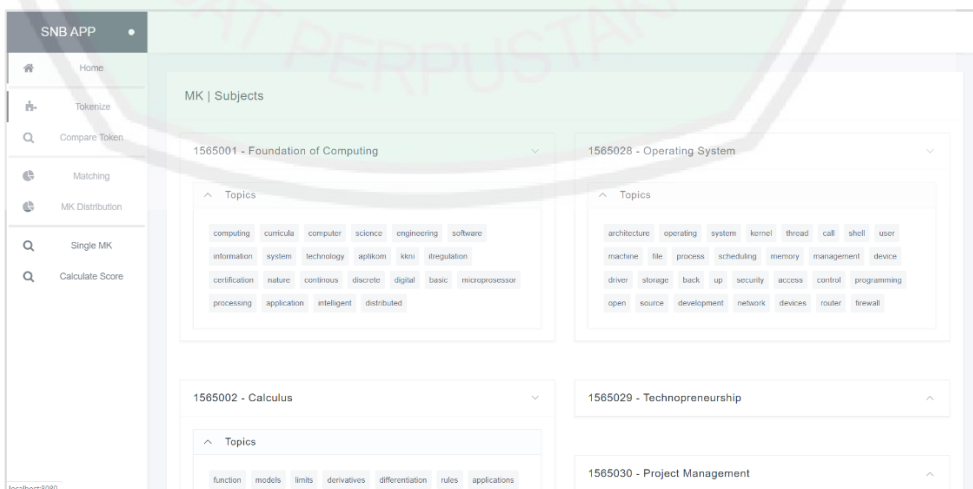


Figure 3.19 Tokenized Page – Subject

For a complete list of tokens or terms knowledge area can be seen in Appendix 2, while for a complete list of tokens or terms from a subject can be seen in Appendix 1.

3.2.3. Naïve Bayes

In this process, the probability of each subject to the knowledge area will be calculated by calculating the probability of the term or token in the subject for each knowledge area, meaning that the results of this calculation will show the probability of each subject for each knowledge area. The following is the source code for implementing the Naïve Bayes method to calculate the probability of terms in the subject in the knowledge area.

```
// assign prob for each KA for each Term
for (let p = 0; p < kaToken.length; p++) {
  termCalObj['kaId'] = kaToken[p].id
  var matched = false
  // check all KA token
  for (let q = 0; q < kaToken[p].tokenized.length; q++) {
    // check if token equals
    if( currentToken == kaToken[p].tokenized[q].toLowerCase()) {
      matched = true
      break
    }
  }
  if (matched){
    //laplace correction
    var termMatchProb = 2 / (tokenAppear + kaToken.length)
    termCalObj['kaProb'].push(termMatchProb)
  }
  else {
    var termMatchProb = 1 / (tokenAppear + kaToken.length)
    termCalObj['kaProb'].push(termMatchProb)
  }
}
}
```

```
var numerator = 1/kaToken.length
// assign term and prob from previous method
for (let k = 0; k < termCalculate.length; k++) {
  var termObj = {}
  termObj['term'] = mkToken[i].tokenized[k]
  termObj['prob'] = termCalculate[k].kaProb[j]
  kaObj['termProb'].push(termObj)
  numerator = numerator * termCalculate[k].kaProb[j]
}
kaObj['finalKaProb'] = numerator
sortedKa.push(kaObj)
```

Figure 3.20 Source Code for Naïve Bayes implementation

In Figure 3.20 above, we first need to find the probabilities of each term in each knowledge area. Since there is a possibility that there is a term whose probability is 0, then Laplace correction is needed to eliminate probability 0. After all, terms have a probability value for each knowledge area, a calculation is performed to determine the subject probability of the knowledge area with elements that are the probability of existing terms in that subject. Following is the display of a matching page after the implementation of Naïve Bayes.

MK - Knowledge Area Match Percentage

Knowledge Area	Terms
1565001 - Foundation of Computing	<ul style="list-style-type: none"> 1. CN - Computational Science 2. HCI - Human-Computer Interaction 3. IAS - Information Assurance and Security 4. SP - Social Issues and Professional Practice 5. IS - Intelligent Systems 6. SE - Software Engineering 7. SF - System Fundamental 8. PD - Parallel and Distributed Computing 9. GV - Graphics and Visualization
1565025 - Geographical Information System	<ul style="list-style-type: none"> 1. GV - Graphics and Visualization 2. CN - Computational Science 3. IS - Intelligent Systems 4. PD - Parallel and Distributed Computing 5. SF - System Fundamental 6. IAS - Information Assurance and Security 7. IM - Information Management 8. NC - Networking and Communication 9. PL - Programming Languages

Figure 3.21 Matching Page – Ranking

MK | Matched Knowledge Area (Table)

#	Mata Kuliah	Knowledge Area
1565001	FOUNDATION OF COMPUTING	CN Computational Science 8.213466657857843e-30%
1565002	CALCULUS	CN Computational Science 1.4946978614018262e-19%
1565003	ALGORITHM & PROGRAMMING 1	PL Programming Languages 5.354058274141670e-25%
1565004	DISCRETE MATHEMATICS	AL Algorithms and Complexity 2.0846098953618713e-55%
1565005	LINEAR ALGEBRA	CN Computational Science 9.514010823028982e-9%
1565006	DATA STRUCTURE	IM Information Management 5.87993893235057e-44%
1565007	ALGORITHM & PROGRAMMING 2	AL Algorithms and Complexity 8.848615630926263e-27%

Figure 3.22 Matching Page – Highest Probabilities

3.2.4. Zeno Dichotomy Paradox

At this stage, each subject has its knowledge area partner, certainly not only one knowledge area but it has a partnership with another knowledge area with the highest to lowest probability sequence. This shows that at this stage the knowledge area already has a collection of subjects that are related to the knowledge area, then based on the calculation of the probability that not all subjects enter the knowledge area of each subject will determine the level of contribution to a knowledge area based on the order of its probability of knowledge area. The following is the implementation source code of Zeno Dichotomy Paradox.

```
// assign MK contributions into each KA
for (let i = 0; i < mkProbKa.length; i++) {
  var divider = 1
  for (let j = 0; j < mkProbKa[i].kaProb.length; j++) {
    divider = divider * 2
    mkProbKa[i].kaProb[j]['contribution'] = 1 / divider
  }
}
```

Figure 3.23 Source Code – Zeno Dichotomy Paradox

The above source gives each knowledge area related to the contribution value subject, starting from the knowledge with the highest probability to get a contribution level of 0.5 then the next knowledge gets a level of 0.25 and then 0.125 and so on.

Following the interface of the subject distribution to the knowledge area page, this page contains a visualization in the form of a card to make it easier for users to see the distribution.

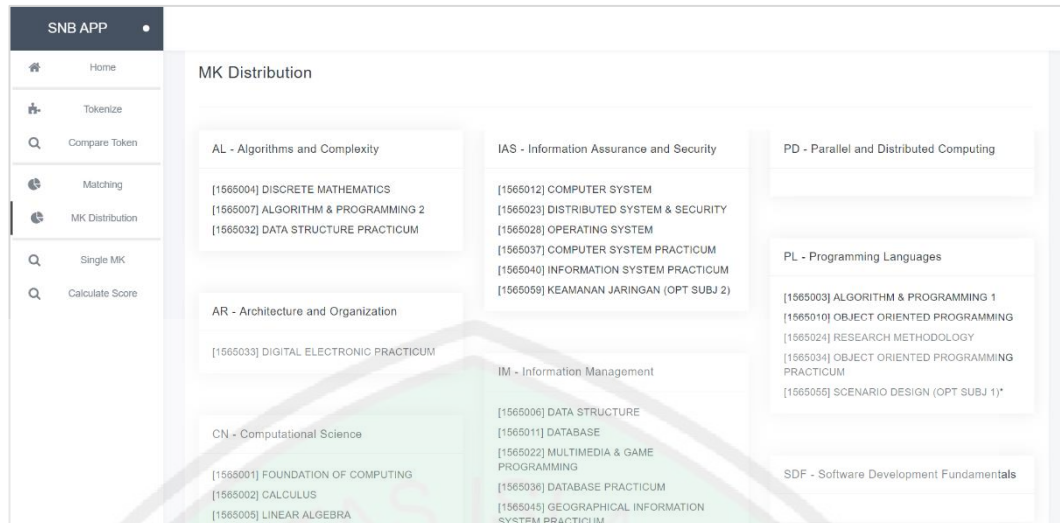


Figure 3.24 Subject Distribution Page

3.2.5. Input Transcript

At this stage the student transcript value will be inputted, using the transcript data from the excel file, the data must be extracted first and to facilitate the transcript input process, then the extracted data will be presented in the form of JSON. Here is the source code for extracting data in an excel file and presenting it in JSON format.

```

$excelReader = PHPEXCEL_IOFactory::createReaderForFile($tmpfname);
$excelReader->setLoadSheetsOnly($nim);
$excelObj = $excelReader->load($tmpfname);
$worksheet = $excelObj->getSheet(0);
$lastRow = $worksheet->getHighestRow();
// append data from excel into variable
$data = [];
for ($row = 6; $row <= $lastRow; $row++) {
    $data[] = [
        'id' => $worksheet->getCell('B'.$row)->getValue(),
        'mkName' => $worksheet->getCell('C'.$row)->getValue(),
        'sks' => $worksheet->getCell('D'.$row)->getValue(),
        'scoreDis' => $worksheet->getCell('F'.$row)->getValue()
    ];
}
echo json_encode($data);

```

Figure 3.25 Source Code – Read Excel and Provide JSON Data



```

[
  {
    "id": 1565003,
    "mkName": "ALGORITMA & PEMROGRAMAN 1",
    "sks": 3,
    "scoreDis": "A"
  },
  {
    "id": 1565006,
    "mkName": "STRUKTUR DATA",
    "sks": 3,
    "scoreDis": "A"
  },
  {
    "id": 1565008,
    "mkName": "ELEKTRONIKA DIGITAL",
    "sks": 3,
    "scoreDis": "A"
  },
  {
    "id": 1565012,
    "mkName": "SISTEM KOMPUTER",
    "sks": 3,
    "scoreDis": "A"
  },
  {
    "id": 1565017,
    "mkName": "JARINGAN KOMPUTER",
    "sks": 3,
    "scoreDis": "A"
  },
  {
    "id": 1565018,
    "mkName": "KECERDASAN BUATAN",
    "sks": 3,
    "scoreDis": "A"
  }
]

```

Figure 3.26 JSON – Student Transcript Scores

From the above data, there are already attributes in the form of subject id, sks, and scores for each subject, next is to enter the value of the transcript data into the application by entering the value of each subject by matching the id of the transcript and application, then the final result of this process every subject in the application gets additional attributes in the form of credits and scores.

3.2.6. Student Academic Performance

This stage is the stage to calculate student performance based on the value of the transcript and subject classification of the knowledge area along with their respective contribution rates. The formula used is Formula 3.4. The following is the source code for implementing the formula.

```

for (let i = 0; i < sMkDist.length; i++) {
  // store total sks and score
  var totalSks = 0
  var totalScore = 0
  for (let j = 0; j < sMkDist[i].mk.length; j++) {
    // sum sks and score
    totalSks += sMkDist[i].mk[j].sks
    totalScore += sMkDist[i].mk[j].score * sMkDist[i].mk[j].sks * sMkDist
[i].mk[j].contribution
  }
  sMkDist[i]['totalSks'] = totalSks
  sMkDist[i]['totalScore'] = totalScore
  sMkDist[i]['totalPerformance'] = totalScore / totalSks
}

```

Figure 3.27 Source Code – Calculate Student Performance

After the process of calculating the academic performance of students, it will produce a list of knowledge areas along with their respective performance values complete with detailed calculations. Next page display calculate student performance.

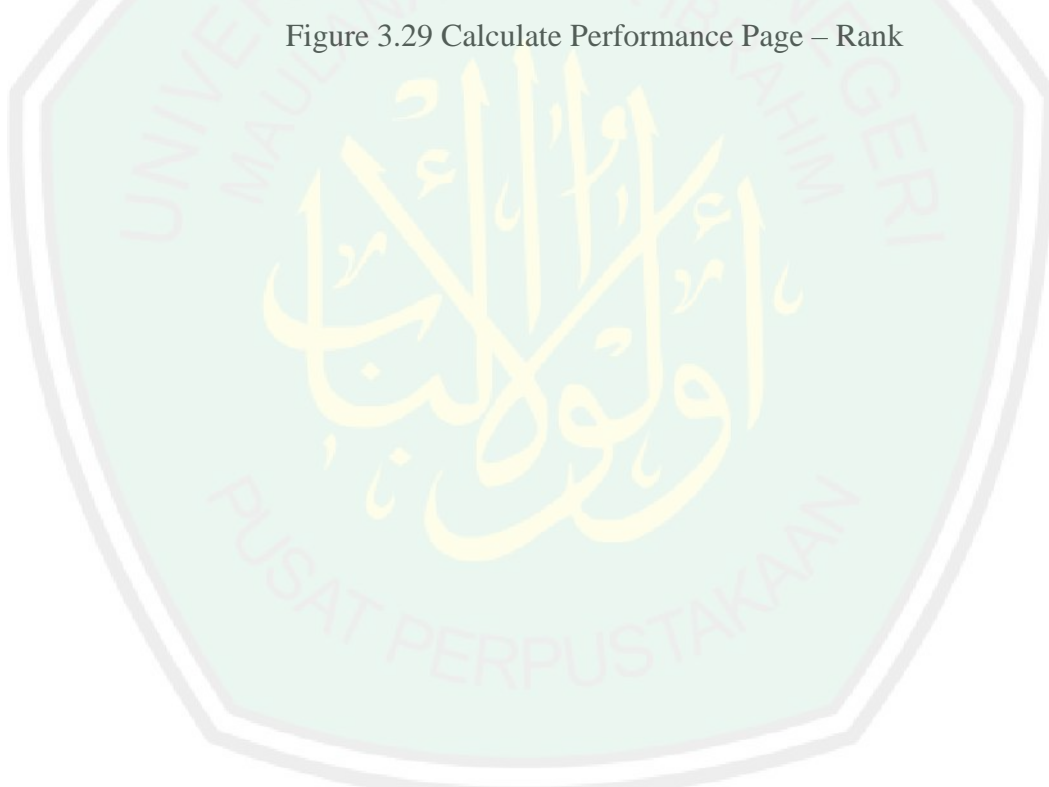


Figure 3.28 Calculate Performance Page – Rank

On that page there are detailed performance calculations for each knowledge area, each knowledge has many subjects that are related and each subject that has that connection has their respective rates of contribution. Following is the display for detailed calculations, the calculations below describe how many courses there are and total credits and total scores multiplied by the level of their contribution.

SNB APP				
2 - HCI - Human-Computer Interaction				
Total Mata Kuliah	47			
Total SKS	105			
Sigma (Nilai * sks) * Kontribusi	(B*2)*50%	(B+*3)*50%	(B+*1)*50%	(B*1)*50%
	(A*3)*50%	(*3)*50%	(A*2)*25%	(B*3)*25%
	(B+*3)*25%	(A*3)*25%	(B*2)*25%	(B+*1)*25%
	(A*3)*12.5%	(A*2)*12.5%	(B+*1)*12.5%	(A*1)*12.5%
	(A*1)*12.5%	(*3)*12.5%	(B*2)*6.25%	(A*3)*6.25%
	(B*3)*6.25%	(A*2)*6.25%	(A*2)*6.25%	(B+*1)*6.25%
	(B*3)*6.25%	(A*3)*3.125%	(B*2)*3.125%	(A*1)*3.125%
	(A*1)*1.5625%	(B+*1)*1.5625%	(*3)*1.5625%	(B+*3)*0.390625%
	(B+*3)*0.390625%	(B+*3)*0.390625%	(A*1)*0.390625%	(A*1)*0.390625%
	(B*3)*0.1953125%	(A*3)*0.1953125%	(*3)*0.1953125%	(C+*2)*0.09765625%
	(B+*3)*0.09765625%	(*3)*0.09765625%	(C*2)*0.01220703125%	(A*3)*0.00152587890625%
	(B*3)*0.00152587890625%	(A*3)*0.000762939453125%	(A*1)*0.000762939453125%	
Hasil Sigma Nilai diatas	38.17231750488281			
1/Sigma SKS X total Sigma Score	0.009523809523809525 * 38.17231750488281			
Total Performance	0.363545880998839			

Figure 3.29 Calculate Performance Page – Rank



CHAPTER 4

EXPERIMENT AND DISCUSSION

This chapter explains the experiment and discussion about this research based on the research purpose mentioned in Chapter 1. Then shows the results of the experiment based on the experiment scenario to calculate the accuracy of the proposed method.

4.1. Experimental Setup

This section will explain the steps in carrying out this experiment. Below will be explained the steps ranging from how to collect data to how to get the final results of this experiment, namely the accuracy of the proposed method.

4.1.1. Data Collection

The data that is already available in the RPS document in the subject in the Jurusan Teknik Informatika UIN Maulana Malik Ibrahim Malang and topics in the knowledge area in IEEE/ACM Computer Science Curricula 2013 are taken by inserting them into variables in the system using the JSON format.

4.1.2. Subject Classification

Classification is done using the naïve Bayes method with a total of 18 classes, namely the number of knowledge areas. Each subject will have a probability for each knowledge area, which the probability will be a reference to determine the level of contribution of the subject to each knowledge area.

Data from the subject and knowledge area are in the form of text that has been packaged in JSON format. The text needs to be preprocessed inserting case folding, tokenizing, and stopword removal. Next will begin to be calculated for the probability of each term in the subject to the terms in the knowledge area to find out what is the final probability of the subject to the knowledge area.

After the subject probability of each knowledge area is obtained, the next step is to enter the contribution level by sorting the knowledge area with the highest to lowest probability and then each knowledge area is given a contribution level based on the Zeno dichotomy paradox concept in which each level is half the previous level starting from 0.5.

4.1.3. Student Academic Performance Calculation

In this section the subject has been classified, next is how to calculate student academic performance. In this calculation, the 7th-semester student transcript will be used which has been packaged in Excel format, which will then be read by the system and converted to the JSON format. After becoming a JSON format, the data can be presented and calculated values and other parameters using Formula 3.4.

4.1.4. Accuracy

The output of this application is the value of student performance in each knowledge area, there are 18 knowledge areas, each of which already has a performance value. So to determine the knowledge area which student has the highest performance then has been sorted in the previous stage to display the knowledge area with the highest to lowest performance.

As already mentioned in chapter 3, this experiment is carried out by calculating the accuracy of the output of this application compiled with input from the expert. At this stage, 20 transcript data for 7th-semester student grades will be taken and input from experts will also be taken, each student's transcript will be input by five experts. The expert will select three of the 18 knowledge areas based on the value of the transcript to determine the three selected knowledge areas to be used as actual conditions or calculation material to calculate the accuracy of this

application. After we get input from experts, the formula for the calculation below can be implemented.

$$\text{Accuracy} = \frac{TP+TN}{TP+TN+FP+FN} \times 100\% \quad (4.1)$$

Based on the formula above, For one student transcript, there will be 18 knowledge areas, the top three of the 18 will be a positive output, and the remaining 15 will be a negative output. TP is the amount of positive knowledge area that is also detected correctly or positively by the system, TN is a negative knowledge area that is also detected wrongly or negatively by the system, FP is a positive knowledge area that is detected wrongly or negatively by the system, and FN is negative data that is detected wrongly by the system.

4.2. Experimental Result

The first part of the results of this experiment is in the form of the probability results of the subject for each knowledge area. These results will determine the level of contribution of the subject to each knowledge area. Following is a table containing subject probabilities in each knowledge area.

Table 4.1 Probability of the Foundation of Computing subject

Subject	Knowledge Area	Probability
1565001 Foundation of Computing	AL - Algorithms and Complexity	1.60419270661286e-32
	AR - Architecture and Organization	1.60419270661286e-32
	CN - Computational Science	8.213466657857843e-30
	DS - Discrete Structures	1.60419270661286e-32
	GV - Graphics and Visualization	2.566708330580576e-31
	HCI - Human-Computer Interaction	8.213466657857843e-30
	IAS - Information Assurance and Security	8.213466657857843e-30
	IM - Information Management	2.566708330580576e-31
	IS - Intelligent Systems	2.0533666644644607e-30
	NC - Networking and Communications	1.283354165290288e-31
	OS - Operating Systems	6.41677082645144e-32
	PBD - Platform-based Development	1.60419270661286e-32
	PD - Parallel and Distributed Computing	5.133416661161152e-31
	PL - Programming Languages	2.566708330580576e-31
	SDF - Software Development Fundamental	6.41677082645144e-32
	SE - Software Engineering	2.0533666644644607e-30
SF - Systems Fundamentals	1.0266833322322304e-30	
SP - Social Issues and Professional Practice	8.213466657857843e-30	

Table 4.1 shows the results of the calculation of the probability of one subject (Foundation of Computing) of the knowledge area. For a table of the probability of subjects to a complete knowledge area can be seen in the table in Appendix 3.

Example of an accuracy calculation, based on Formula 4.1. One student transcript with Student ID 16650012 based on the output system has the top three knowledge namely IAS, HCI, and SE. Meanwhile, based on expert input, the transcript has the top three knowledge, namely SE, CN, and SP, the calculation is as follows.

$$\begin{aligned} \text{Accuracy} &= \frac{TP + TN}{TP + TN + FP + FN} \times 100\% \\ &= \frac{1 + 13}{1 + 13 + 2 + 2} \times 100\% \end{aligned}$$

Where:

TP = 1 (SE)

TN = 13 (18 knowledge area except IAS, HCI, CN, SP, SE)

FP = 2 (CN and SP)

FN = 2 (IAS and HCI)

From the example above, the accuracy of the student transcript with Student ID 16650012 is 77.78%. That is still from one transcript and there will still be 19 more trials, then final accuracy will be obtained from an average of 20 trials. The remaining 19 students have more transcripts whose accuracy will be shown in Table 4.2 below.

Table 4.2 Result of Calculation – Knowledge Area

NIM	Output System	Expert Input
16650012	IAS, HCI and SE	SE, SP, and CN
16650013	IAS, HCI, and CN	SP, SE and GV
16650015	IAS, CN and SE	CN, SE and SP
16650016	IAS, CN and SE	IAS, IM and SP
16650020	IAS, HCI and CN	CN, GV and SE
16650021	IAS, HCI and CN	IAS, SE and CN
16650029	IAS, HCI and CN	SE, PL and SP
16650031	IAS, SE and HCI	IAS, SP and IM
16650035	IAS, SE and CN	SE, IAS and GV
16650037	IAS, HCI and SE	PBD, SE, and GV
16650039	IAS, SE and CN	SE, CN and PBD
16650040	IAS, HCI and CN	GV, CN and IM
16650056	IAS, HCI and CN	SE, CN and IM
16650084	IAS, CN and SE	PBD, IAS and GV
16650085	IAS, HCI and CN	SE, SP and IM
16650086	IAS, HCI and CN	PD, CN, and SDF
16650087	IAS, HCI and CN	CN, GV and SDF
16650097	IAS, HCI and CN	CN, IAS and SDF
16650102	IAS, CN and HCI	SP, CN and GV
16650115	IAS, HCI and CN	CN, IM and SP

Data in the form of expert input in each of the students above were obtained from the input of several experts. To explain how input from the expert was obtained, it will be explained with an example of one of the students listed in Table 4.2. Students with NIM 16650012 get input from experts namely SE, SP, and CN. The knowledge area is obtained from the input of five experts in detail in Table 4.3 below.

Table 4.3 Expert Input for Student with ID 16650012

Expert Input	Knowledge Area
Expert 1	SE, SP, and CN
Expert 2	CN, SE and SP

Expert 3	IM, SE and SP
Expert 4	GV, SE and SP
Expert 5	CN, SF and GV

From Table 4.3 above, it can be seen that the input of the five experts varies, so to determine the three selected knowledge areas is to calculate the frequency of each knowledge area based on the input of some of these experts. Therefore based on input from the five experts, it can be determined that the top three knowledge areas for students with ID 16650012 are SE, SP, and CN.

Table 4.4 Result of Calculation – Accuracy

NIM	TP	FP	TN	FN	Accuracy
16650012	1	2	13	2	77.77777778%
16650013	0	3	12	3	66.66666667%
16650015	2	1	14	1	88.88888889%
16650016	1	2	13	2	77.77777778%
16650020	1	2	13	2	77.77777778%
16650021	2	1	14	1	88.88888889%
16650029	0	3	12	3	66.66666667%
16650031	1	2	13	2	77.77777778%
16650035	2	1	14	1	88.88888889%
16650037	1	2	13	2	77.77777778%
16650039	2	1	14	1	88.88888889%
16650040	1	2	13	2	77.77777778%
16650056	1	2	13	2	77.77777778%
16650084	1	2	13	2	77.77777778%
16650085	0	3	12	3	66.66666667%
16650086	1	2	13	2	77.77777778%
16650087	1	2	13	2	77.77777778%
16650097	2	1	14	1	88.88888889%
16650102	1	2	13	2	77.77777778%
16650115	1	2	13	2	77.77777778%

The table above shows the details of the accuracy variables in the form of TP, FP, TN, and FN which were obtained from two classes, namely positive and

negative, positively represented as the top three knowledge areas, and negative classes represented as 15 unselected knowledge areas.

From the results of the 20 test results above, it can be seen that the accuracy of the academic performance identification system of this student is 78.95%. These results are results that are purely based on existing data, namely terms that are in the subject and terms that are in the knowledge area. And the value that is on each student transcript that also gets input from the results of identification by experts.

4.3. Discussion

In this discussion section, it will explain the analysis of the subject classification results, student academic performance, and accuracy. The first is the result of the classification, it has been mentioned that there is a distribution of subjects to knowledge areas and their contribution rates. The results of the classification are the result of calculations using the Naïve Bayes method which depends on the probability term. In this study, all results are based on data, meaning the data conditions that determine the results of the classification, therefore the role of the RPS document is very important because it determines the classification, there are many differences of opinion from experts regarding the classification of subjects in the knowledge area, but again that the results in the study This is based on the terms contained in the RPS document.

Next is the academic performance of students, academic performance is also based on data which involves scores and subject or credit load. The results of this academic performance calculation are based on the contribution of each subject to the knowledge area. If we look back at the top, the output results of this system tend to be similar because indeed the distribution of the contribution of subjects to the

knowledge area tends to be higher to the knowledge area and it is based on the dataset.

Next the third is accuracy, it is mentioned in the experimental results that the accuracy of this system is 78.95%. It can be seen in Table 4.3 above that the accuracy has only a few kinds because the first input from experts is the top three knowledge areas which cause the highest likelihood for TP is 3, as well as for others. And the error in the system when compared with expert input is the classification generated by the system based on the dataset and the expert version classification has a difference that also affects the calculation in the final output of the application, which is the academic performance of students through a formula involving SKS and contribution rates too.

The last one is research integrated with the Qur'an. This research aims to identify the academic performance of students based on IEEE/ACM Computer Science Curricula 2013, in the process requires classification in advance to classify the subject in Jurusan Teknik Informatika curriculum of UIN Maulana Malik Ibrahim Malang with the knowledge area in the IEEE/ACM Computer Science Curricula 2013. In general with knowledge accordingly, the subject can be classified by experts in their fields. However, in this study classification will be carried out using the terms contained in the study material in each subject and topic in the knowledge area using the method proposed above. Of course, this research aims to find out how accurate the system is in determining academic performance with the aforementioned scenarios. Allah says in the An-Najm verse 28:

شَيْئاً الْحَقُّ مِنْ يُعْنِي لَا الظَّنَّ وَإِنَّ الظَّنَّ إِلَّا يَتَّبِعُونَ إِنَّ عِلْمٌ مِنْ بِهِ لَهُمْ وَمَا

Means: “And they don't have any knowledge about it. They are nothing but following the allegation while the truth is that there is no benefit to the truth”.

based on Al-Jalalain's Tafsir from the book of Tafsir Jalalain it is stated that "(and they did not base their words) their words were not based (with any knowledge about it. Nothing else they just followed) in the matter (prejudices) that they imagined (whereas actually prejudice did not have the slightest benefit to the truth) that is to say, there is not the slightest useful knowledge in that prejudice in examining the things that demand knowledge" (Muhammad & Abdurrahman, 2009). Allah SWT. said that there was no benefit in following something that was still presumptive. So to prevent people from following the presumption, it is necessary to have research to find out or prove a thing.

عَلَىٰ وَفَضَّلْنَاهُمْ الطَّيِّبَاتِ مِنَّا وَرَزَقْنَاهُمْ وَالْبَحْرِ الْبَرِّ فِي وَحَمَلْنَاهُمْ أَدَمَ بَنِي كَرَمَنَا وَقَدُّ
تَفْضِيلًا خَلَقْنَا مِمَّنْ كَثِيرٍ

Means : “And indeed, We have glorified Adam's children and grandchildren, and We transported them on land and on the sea, and We gave them sustenance from the good and We exaggerated them above the many creatures We created with perfect advantages.” (QS. Al-Isro : 70)

Based on the Quraish Shihab's Tafsir from the book of Tafsir Al-Mishbah Volume 7 of the above verse it is stated that "Really We have glorified Adam's children and grandchildren with good body shape, speech skills and freedom of choice. We give them glory and strength if they obey Us. We transport them on land, through animals, and We also transport them in the sea, through ships. We also provide them with a variety of pleasures. Indeed, We have exaggerated them with the mind of most other creatures that We created." (Shihab, Tafsir Al-Misbah

Pesan, Kesan dan Keserasian Al-Qur'an, 2005). The above verse explains that every human being at birth has been given an advantage over other creatures created by God. the output produced from this application is the academic performance of students following the existing knowledge area in the IEEE/ACM Computer Science Curricula 2013. In this research, what makes a person have an advantage over another one of which is his ability in a particular field.



CHAPTER 5

CONCLUSION AND SUGGESTION

5.1. Conclusion

From the result of the implementation and experiments that have been carried out by researchers, it can be concluded that the accuracy from this study is 78.95%, obtained from the output system test result and input from the experts. This accuracy result is influenced by several factors, where the biggest factor is the result of the classification of subjects in the system based on pure datasets of RPS documents in Jurusan Teknik Informatika UIN Maulana Malik Ibrahim Malang and IEEE/ACM Computer Science Curricula 2013.

5.2. Suggestion

in this study the researchers realized that from the process above is still not perfect, there needs to be further development of what has been done in this study, the researcher has several suggestions for further research as follow:

- a. Reconsider the number of subjects that enter the knowledge area, or optimize the rules for processing existing probabilities because the more number of subjects the more dividers there are for the transcript value when calculating academic performance.
- b. In this study the amount of knowledge area that is considered positive or the knowledge area that is considered best by the expert is taken the top three, will be a good comparison for this study if in subsequent studies add the amount of input from the expert.

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APPENDIX

Appendix 1

List of subjects and collection of terms in the subject

No	Subjects	Terms
1	1565001 - Foundation of Computing	computing - curricula - computer - science - engineering - software - information - system - technology - aptikom - kkni - itregulation - certification - nature - continous - discrete - digital - basic - microprocessor - processing - application - intelligent - distributed
2	1565002 - Calculus	function - models - limits - derivatives - differentiation - rules - applications - differentiation - integral - its - differential - equations - infinite - sequences - series
3	1565003 - Algorithm & Programming 1	history - programming - logic - notation - flowchart - syntax - data - type - variable - conditional - iteration - looping - block - structure - nested - procedure - function - recursive - pseudocode
4	1565004 - Discrete Mathematics	boolean - algebra - logical - statements - set - theory - ordered - structure - tuples - lists - string - languages - relations - counting - graph - tree - function - injection - surjection - bijection - inverses - pigeonhole - principle - simple - ciphers - hash - countability - analysis - techniques - algorithm - finding - closed - forms - discrete - probability - permutation - combination - rates - growth - big - theta - litle - o - omega
5	1565005 - Linear Algebra	linear - equation - matrix - vector - eigen - value
6	1565005 - Data Structure	data - type - bit - byte - boolean - character - integer - real - structure - storage - array - record - set - stack - queue - heap - linked - list - graph - tree - binary - avl - b - r - traversal - breadth - first - depth - memory - management - garbage - collection - sorting - searching
7	1565007 - Algorithm & Programming 2	flowchart - pseudocode - searching - binary - search - depth - first - breadth - topological - sort - backtracking - divide - conquer - sorting - selection - greedy - algorithms - hill - climbing - brute - force - analysis
8	1565008 - Digital Electronic	binary - notation - decimal - hexadecimal - logic - gates - and - or - xor - karnaugh - map - flip - flop - decoder - encoder - multiplexer - demultiplexer - integrated - circuit - ttl - cmos - clocking

9	1565009 - Statistics	descriptive - statistics - visualization - tabulation - graph - central - tendency - mean - median - quartile - dispersion - skewness - standard - deviation - variance - probability - distribution - discrete - continue - normal - gaussian - poisson - binomial - sampling - population - parameter - estimation - hypothesis - tests - analysis - regression - correlation
10	1565010 - Object Oriented Programming	operator - constant - data - type - variable - object - class - constructor - control - flow - looping - branching - conditional - encapsulation - overriding - inheritance - polymorphism - interface - abstraction - packages - exception - handling
11	1565011 - Database	concept - architecture - dbms - data - model - hierarchical - relational - network - sql - query - normalization - concurrency - back - up - recovery - security - authorization - access - control - privileges - entity - relationships - diagram
12	1565012 - Computer System	microprocessor - alu - registry - address - bus - interrupt - reset - system - memory - i - o - decoder - clocking - interfacing - bootstrap - microcontroller - computer - boot - loader - management - interrupt - intercept - assembly - language - parallel - serial - communication - ppi - rs232 - embedded
13	1565013 - Numerical Methods	interpolation - lagrange - cubic - spline - curve - fitting - simultaneous - algebraic - equations - gauss - elimination - jordan - matrix - inversion - seidel - eigen - values - differentiation - integration - stirling - newton - cotes - trapezoidal - romberg - simpson - taylor - picard - euler - runge - kutta - predictor - corrector
14	1565014 - Web Programming	html - xml - css - php - framework - java - script
15	1565015 - Software Engineering	software - development - model - uml - dfd - requirement - analysis - specification - design - process - object - prototyping - extreme - programming - user - experience - testing - maintenance - quality - assurance - it - audit - evolution - project - proposal
16	1565016 - Computer Graphic	drawing - texturing - basic - shapes - modeling - complex - object - polygonal - procedural - moving - objects - view - angle - geometric - transformation - rendering - animation
17	1565017 - Computer Network	internet - layer - osi - circuit - switch - packet - network - device - hub - router - physical - cable - optic - frequency - distortion - noise - data - link - ethernet - atm - ppp - frame - relay - switching - wireless - tdma - cdma - fdma - mac - arp - rarp - ip

		- icmp - subnetting - supernetting - routing - virtual - transport - tcp - udp - wan - architecture - public - private - firewalling - dns - mail - server - web - monitoring - administering
18	1565018 - Artificial Intelligence	heuristic - reasoning - past - experience - hill - climbing - forward - chaining - backward - expert - system - rule - case - neural - network - fuzzy - logic - genetic - algorithm - rough - set
19	1565019 - Computer Vision	image - processing - vision - video - acquisition - lenses - system - sensor - metrics - pixel - intensity - colour - contrast - frequency - resolution - enhancement - noise - convolution - filter - morphology - gradient - thresholding - registration - projection - feature - extraction - edge - shape - texture - centroid - moment - distance - volume - pattern - analysis - understanding - template - matching - recognition - accuracy - precision - object - modeling - polygonal - procedural - geometric - transformation - application - spatial - medical - imaging - biometric
20	1565020 - Mobile Programming	android - ios - java - micro - edition - application - development - software - specification - studio - hardware - type - layout - xml - internet - api - library - xcode - ide - compatible - os - design - coding - mobile - applications - deployment
21	1565021 - Information System	business - process - requirement - engineering - standrad - operating - procedure - sop - development - information - system - design - physical - logical - documentation - flow - modeling - dfd - erd - conceptual - model - uml - case - diagram - implementation - evaluation - black - box - white - testing - enterprise - resource - planning - erp
22	1565022 - Multimedia & Game Programming	basic - scenario - design - gaming - object - obstacle - entity - bonus - score - non - player - character - intelligence - behaviour - fsm - msm
23	1565023 - Distributed System & Security	osi - layer - thread - process - management - socket - client - server - java - rmi - remote - procedure - call - corba - security - authentication - access - control - authorization - encryption - public - private - key - network - intrusion - detection - monitor - firewalling - spoofing - web - sql - injection - brute - force
24	1565024 - Research Methodology	nature - research - scientific - approach - type - exploratory - constructive - empirical - quantitative - qualitative - problem - question - objective - scope - literature - review - state - art - reference - design - procedure - data - sources - acquisition -

		collection - instruments - methods - analyse - system - development - experiment - discussion - framework - theoretical - conceptual - operational - preliminary - result - developing - abstract - keywords - conclusion - title
25	1565025 - Geographical Information System	digital - map - coordinate - system - datum - projection - type - spatial - raster - vector - tabular - database - digitization - image - registration - overlaying - webgis - remote - sensing - satellite - photo - analysis
26	1565026 - Operation Research	linear - programming - break - event - point - simplex - transportation - problem - network - game - theory - decision - analysis - markov - chains - queuing - inventory - forecasting
27	1565027 - Human Computer Interaction	manmachine - interaction - ergonomics - design - interfacing - development - navigation - dialog - efficiency - user - friendly - usability
28	1565028 - Operating System	architecture - operating - system - kernel - thread - call - shell - user - machine - file - process - scheduling - memory - management - device - driver - storage - back - up - security - access - control - programming - open - source - development - network - devices - router - firewall
29	1565029 - Technopreneurship	business - plan - proposal - feasibility - profitability - study - cost - estimation - break - event - point - banking - system - interest - rate - product - deployment - marketing
30	1565030 - Project Management	project - elements - management - planning - scope - definition - activities - sequencing - resource - time - estimation - scheduling - cost - budget - development - risk - opportunities - techniques - evaluation - feasibility - study - profitability - analysis - network - optimization - learning - curve - analysis - documentation - control - it - selection - iso - itil - cobit
31	1565031 - Algorithm & Programming 1 Practicum	java - editor - syntax - data - types - keywords - variables - operators - conversion - techniques - input - keyboard - control - structure - looping - array - dimension - multidimensional - exception - handling - method - basic - gui - graphical - user - interface - event - action - program - database - programming
32	1565032 - Data Structure Practicum	arrays - simple - sort - stacks - queues - linked - list - recursion - advance - sorting - binary - trees - hash - tables - heaps - graps
33	1565033 - Digital Electronic Practicum	resistor - capacitors - semiconductor - diodes - transistor - basic - logic - gate - independent - combination - series - boolean - algebra - karnaugh

		- map - multiplexers - demultiplexers - encoder - decoder - flip - flop - shift - register - counter
34	1565034 - Object Oriented Programming Practicum	operator - constant - data - type - variable - object - class - constructor - control - flow - looping - branching - conditional - encapsulation - overriding - inheritance - polymorphism - interface - abstraction - packages - exception - handling
35	1565035 - Mobile Programming Practicum	android - programming - layout - widget - splash - screen - list - view - connect - database - sqlite - api - ios - table - core
36	1565036 - Database Practicum	installation - creation - management - tables - sql - basic - commands - operators - normalization - aggregation - view - sub - query - index - function - pl - postgresql - connections - java - netbeans - making - lapaoran - with - i - report
37	1565037 - Computer System Practicum	microprocessor - alu - registry - address - bus - interrupt - reset - system - memory - i - o - decoder - clocking - interfacing - bootstrap - microcontroller - computer - boot - loader - management - interrupt - intercept - assembly - language - paralel - serial - communication - ppi - rs232 - embedded
38	1565038 - Web Programming Practicum	materials - tools - html - html5 - css - java - script - php - basics - scripting - element - object - oriented - connection - crud - database - session - cookie - management - modules - file - operators - jsp - directive - beans - mysql - cookies - module - concepts - operations
39	1565039 - Software Engineering Practicum	software - projects - feasibility - study - use - case - diagrams - information - development - modeling - requirement - analysis - requirements - specifications - web - services
40	1565040 - Information System Practicum	case - study - information - system - building - block - joget - org - implementation - bpmn - dfd - dbms - application - web - service - uses - nusoap - ordinary - esb
41	1565041 - Computer Graphic Practicum	interface - modeling - character - texturing - color - shape - eyes - rigging - animation - environment - model - lighting - animate - video - editing -
42	1565042 - Computer Network Practicum	cabling - subneting - class - c - netmask - b - a - workstation - adhoc - settings - basic - access - point - static - routing - using - cisco - mikrotik - dynamic - nat - dhcp - server - microtics - vlan - configuration - trunking
43	1565043 - Multimedia & Game Programming Practicum	starting - unity - making - terrain - lighting - third - person - shooter - first - model - settings - animation - player - opponent - add - effects - scoring - augmented - reality - vuforia

44	1565044 - Distributed System Practicum	internet - address - data - streams - object - serialization - user - datagram - protocol - transmission - control - multithread - programming - jade - agent - simulation - local - networks - remote - method - invocation - cryptography
45	1565045 - Geographical Information System Practicum	arcview - digitizing - point - attribute - data - analysis - function - output - web - gis - google - maps - api - make - map
46	1565049 - Soft Computing (Opt Subj 1)*	soft - computing - hard - machine - learning - neural - network - fuzzy - logic - genetic - algorithm - rough - set
47	1565050 - Visualization & Modeling (Opt Subj 2)*	data - visualization - 2d - 3d - modeling - spatial - computer
48	1565051 - Software Quality (Opt Subj 1)*	requirement - analysis - software - quality - assurance - standard
49	1565052 - Software Management (Opt Subj 2)*	managing - software - design - development - evaluation - resources - framework - management
50	1565053 - Enterprise Architecture (Opt Subj 1)*	erp - soa - roa - middle - ware - distributed - architecture - database - system
51	1565054 - It Governance (Opt Subj 2)*	itil - togaf - cobit
52	1565055 - Scenario Design (Opt Subj 1)*	scenario - story - board - design - generation - static - dynamic - automatic - evaluation
53	1565056 - Creative Game & Animation (Opt Subj 2)*	concept - creative - immersive - game - design - sensor - system - development - integrating - environment - calibration - performance - evaluation
54	1565057 - Isu Sosial & Praktek Profesional (Opt Subj 1)	computer - history - ethics - law - professionalism - work - problem - theft - piracy - roboethics - privacy
55	1565089 - Keamanan Jaringan (Opt Subj 2)	computer - network - topology - bus - ring - star - tree - mesh - osi - tcp - ip - layer - general - protocols - udp - icmp - ftp - ssh - http - https - weaknesses - user - side - personal - social - engineering - devices - cracks - backdoor - application - calibration - game - performance - evaluation - cable - switch - hub - tap - port - wireless - packet - sniffing - mitm - attack - server - physical - system - op - exploitation - users - password - bruteforce - phishing - viruses - malware - networks - arp - poison - dns - cache -

	<p>poisoning - dhcp - rogue - exploit - scanning - os - weakness - ddos - sql - injection - xss - mitigation - risk - backup - procedures - firewall - nids - nips - vlan - mitigating - ufw - filtering - log - auditing - monitoring - security - policy - ite - law - iso - 27001 - 27002 - sop - proof - concept</p>
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Appendix 2

List of knowledge areas and collection of terms in the knowledge areas

No	Knowledge Area	Terms
1	AL - Algorithms and Complexity	worst - case - behaviors - algorithm - asymptotic - analysis - upper - complexity - bounds - big - o - notation - formal - definition - classes - constant - logarithmic - linear - quadratic - exponential - empirical - measurements - performance - time - space - trade - offs - algorithms - little - omega - theta - recurrence - relations - iterative - recursive - version - master - theorem - brute - force - greedy - divide - conquer - cross - reference - sdf - design - problem - solving - strategies - backtracking - dynamic - programming - branch - bound - heuristics - reduction - transform - simple - numerical - computing - average - list - numbers - finding - min - max - mode - approximating - square - root - number - greatest - common - divisor - sequential - binary - search - sorting - selection - insertion - n - log - quicksort - heapsort - mergesort - hash - tables - avoiding - resolving - collisions - trees - graphs - graph - heaps - pattern - matching - string - text - substring - regular - expression - longest - subsequence - finite - state - machines - expressions - halting - context - grammars - pl - syntax - p - np - complete - class - exemplary - problems - sat - knapsack - review - introduce - exp - polynomial - hierarchy - completeness - cook - classic - techniques - languages - deterministic - automata - dfas - nondeterministic - nfas - equivalence - closure - properties - proving - pumping - lemma - alternative - push - down - pdas - relationship - turing - equivalent - model - universal - computation - chomsky - church - thesis - computability - rice - examples - uncomputable - function - implications - uncomputability - balanced - avl - red - black - splay - treaps - topological - sort - strongly - connected - components - advanced - structures - b - fibonacci - suffix - arrays - tries - network - flows - flow - ford - fulkerson - cut - maximum - bipartite - duality - simplex - interior - point - theoretic - modular - arithmetic - primality - testing - integer - factorization - geometric - points - line - segments - polygons - intersections - convex - hull - spatial - decomposition - collision - detection - proximity -

		randomized - stochastic - approximation - amortized - probabilistic - online - competitive
2	AR - Architecture and Organization	history - architecture - combinational - sequential - logic - field - programmable - gate - arrays - fundamental - building - block - multiple - representations - layers - interpretation - hardware - layer - aided - design - process - architectural - register - transfer - notation - description - language - verilog - vhdl - physical - constraints - delays - fan - out - energy - power - bits - bytes - words - numeric - representation - number - bases - fixed - floating - point - systems - signed - twos - complement - character - codes - graphical - records - basic - organization - von - neumann - machine - control - unit - instruction - fetch - decode - execution - sets - types - manipulation - o - assembly - programming - formats - addressing - modes - subroutine - call - return - mechanisms - cross - reference - pl - translation - interrupts - heap - static - stack - code - segments - shared - memory - multiprocessors - multicore - simd - mimm - flynn - taxonomy - fundamentals - handshaking - buffering - programmed - interrupt - driven - structures - vectored - prioritized - acknowledgment - external - storage - drives - buses - bus - protocols - arbitration - direct - access - dma - networks - communications - remote - multimedia - support - raid - architectures - implementation - simple - datapaths - pipelining - hazard - detection - resolution - hardwired - realization - microprogrammed - level - parallelism - ilp - law - example - interconnection - hypercube - shuffle - exchange - mesh - crossbar - multiprocessor - consistency - cache - coherence - superscalar - branch - prediction - speculative - order - prefetching - vector - processors - gpus - multithreading - scalability - alternative - vliw - epic - accelerators - kinds - special - purpose
3	CN - Computational Science	models - abstractions - situations - simulations - dynamic - modeling - simulation - techniques - physical - human - loop - guided - virtual - reality - foundational - approaches - validating - comparing - output - real - model - presentation - results - form - relevant - system - being - modeled - purpose - optimization - supporting - decision - making - forecasting - safety - considerations - training - education - tradeoffs - performance - accuracy - validity - complexity - process - identification - key - characteristics - behaviors - simplifying -

		<p>assumptions - validation - outcomes - building - mathematical - formulas - equations - graphs - constraints - methodologies - time - stepping - systems - formal - descriptions - involving - avoiding - detail - examples - include - monte - carlo - stochastic - processes - queuing - theory - petri - nets - colored - graph - structures - directed - trees - networks - games - game - things - linear - programming - extensions - differential - ode - pde - state - spaces - transitions - assessing - evaluating - variety - contexts - verification - important - application - areas - health - care - diagnostics - economics - finance - city - urban - planning - science - engineering - software - support - packages - languages - fundamental - algorithm - consisting - finite - number - well - steps - which - completes - amount - does - entire - known - algorithms - sorting - searching - analysis - understanding - what - problem - really - asking - approached - information - represented - machine - development - workflow - converting - executable - code - lifecycle - requirements - design - implementation - maintenance - representation - arithmetic - numerical - numerically - fitting - newton - architectures - computation - parallel - properties - distributed - bandwidth - latency - scalability - granularity - parallelism - task - event - processor - memory - caching - paradigms - threading - message - passing - driven - mapreduce - grid - computing - impact - architecture - computational - total - curve - continuum - costs - cost - value - storing - lookup - principles - visualization - graphing - image - processing - concerns - content - management - frameworks - im - digital - representations - numbers - text - images - raster - vector - video - quicktime - mpeg2 - mpeg4 - audio - written - score - midi - sampled - digitized - sound - track - animations - complex - composite - aggregate - objects - frbr - creation - capture - preservation - digitization - sampling - compression - conversion - transformation - translation - migration - emulation - crawling - harvesting - structure - libraries - static - stream - aspects - databases - document - collections - multimedia - pools - hyperbases - hypertext - hypermedia - catalogs - repositories - knowledge - ontologies - triple - stores - semantic - rules - pattern - recognition - indexing - queries - query - central - federated - p2p - retrieving - clustering - classifying -</p>
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		categorizing - analyzing - mining - extracting - rendering - reporting - handling - transactions - user - society - interaction - browse - search - filter - route - visualize - share - collaborate - rate - annotate - personalize - recommend - logical - error - stability - convergence - truncation - round - off - function - approximation - taylor - series - interpolation - extrapolation - regression - differentiation - integration - simpson - rule - explicit - implicit - euler
4	DS - Discrete Structures	sets - venn - diagrams - union - intersection - complement - cartesian - product - power - cardinality - finite - relations - reflexivity - symmetry - transitivity - equivalence - partial - orders - function - surjections - injections - bijections - inverses - composition - propositional - logic - cross - reference - reviewed - knowledge - reasoning - logical - connectives - truth - tables - normal - forms - conjunctive - disjunctive - validity - well - formed - formula - inference - rules - modus - ponens - tollens - predicate - universal - existential - quantification - limitations - expressiveness - issues - notions - implication - converse - inverse - contrapositive - negation - contradiction - structure - mathematical - proofs - direct - disproving - counter - example - proof - induction - over - natural - numbers - structural - weak - strong - first - second - principle - recursive - definitions - orderings - counting - arguments - set - sum - rule - inclusion - exclusion - arithmetic - geometric - progressions - pigeonhole - permutations - combinations - basic - pascal - identity - binomial - theorem - solving - recurrence - al - analysis - simple - relation - fibonacci - examples - showing - variety - solutions - modular - trees - properties - traversal - strategies - undirected - graphs - directed - weighted - spanning - forests - graph - isomorphism - probability - space - events - axioms - measures - conditional - bayes - independence - integer - random - variables - bernoulli - expectation - linearity - variance
5	GV - Graphics and Visualization	media - applications - user - interfaces - audio - video - editing - game - engines - cad - visualization - virtual - reality - digitization - analog - resolution - limits - human - perception - pixels - visual - display - dots - laser - printers - samples - hci - foundations - standard - apis - construction - uis - formats - gui - lossless - lossy - additive - subtractive - color - models - cmyk - rgb - these - provide - range - colors

	<p>- tradeoffs - between - storing - computing - embodied - vector - raster - representations - images - animation - sequence - double - buffering - rendering - nature - emission - scattering - light - relation - numerical - integration - forward - backward - ray - casting - rasterization - polygonal - representation - basic - radiometry - similar - triangles - projection - model - affine - coordinate - system - transformations - tracing - visibility - occlusion - solutions - problem - depth - paint - er - algorithm - equation - simple - triangle - shader - api - texture - mapping - minification - magnification - trilinear - mip - application - spatial - structures - sampling - anti - aliasing - scene - graphs - graphics - pipeline - geometric - operations - intersection - calculation - proximity - tests - volumes - voxels - point - parametric - polynomial - curves - surfaces - implicit - approximation - techniques - bezier - spline - uniform - rational - basis - nurb - spines - level - set - surface - tessellation - mesh - fairing - generation - delaunay - triangulation - marching - cubes - subdivision - procedural - fractals - generative - modeling - systems - graftals - cross - referenced - programming - languages - grammars - generated - pictures - elastically - deformable - freeform - multiresolution - reconstruction - constructive - solid - geometry - csg - approximations - example - distribution - path - photon - bidirectional - reyes - micropolygon - metropolis - transport - time - motion - blur - lens - position - focus - continuous - frequency - impact - shadow - culling - function - bsdf - theory - microfacets - subsurface - area - sources - field - image - photorealistic - gpu - architecture - adaptation - sensitivity - noise - flicker - fusion - inverse - kinematics - collision - detection - response - rules - boids - crowds - particle - skinning - algorithms - physics - motions - rigid - body - dynamics - physical - mass - spring - networks - cloth - flesh - hair - key - frame - splines - rotations - quaternions - camera - capture - 2d - 3d - scalar - fields - isosurfaces - direct - volume - transfer - segmentation - ovector - flow - dataotime - varying - dataohigh - dimensional - dimension - reduction - parallel - coordinates - onon - multi - variate - tree - graph - structured - text - perceptual - cognitive - drive - abstractions - design - evaluation</p>
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6	HCI - Human-Computer Interaction	<p>contexts - hci - anything - user - interface - webpage - business - applications - mobile - games - processes - centered - development - early - focus - users - empirical - testing - iterative - design - different - measures - evaluation - utility - efficiency - learnability - satisfaction - usability - heuristics - principles - physical - capabilities - inform - interaction - color - perception - ergonomics - cognitive - models - attention - recognition - movement - memory - gulfs - expectation - execution - social - culture - communication - networks - organizations - good - designers - engineering - tradeoffs - accessibility - interfaces - differently - abled - populations - blind - motion - impaired - aged - population - groups - children - 80 - graphical - guis - elements - visual - layout - fonts - labeling - task - analysis - qualitative - aspects - generating - analytic - low - fidelity - paper - prototyping - quantitative - techniques - keystroke - level - help - documentation - handling - human - system - failure - standards - software - architecture - patterns - model - view - controller - command - objects - online - offline - cross - reference - pl - event - driven - reactive - programming - where - mvc - used - context - hierarchy - navigational - distance - management - geometry - gv - geometric - modelling - choosing - styles - presenting - information - navigation - representation - manipulation - animation - scene - graphs - widget - classes - libraries - modern - gui - ios - android - javafx - builders - ui - environments - pbd - platforms - declarative - specification - stylesheets - doms - database - backed - web - pages - platform - resource - constrained - devices - small - approaches - characteristics - process - functionality - requirements - se - gathering - interviews - surveys - ethnographic - contextual - enquiry - presentation - reports - personas - sketching - storyboards - wireframes - without - both - walkthroughs - goms - expert - guidelines - observation - think - aloud - interview - survey - experiment - challenges - effective - sampling - generalization - results - evaluations - internationalization - designing - cultures - cultural - representing - implementation - mouse - touch - multi - shared - embodied - large - new - input - modalities - sensor - location - windows - iphone - androidospeech - natural - language - processing - wearable - tangible - persuasive - emotion - ubiquitous - aware -</p>
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		<p>technologies - ubicomp - bayesian - inference - predictive - text - guided - pointing - ambient - peripheral - display - asynchronous - group - mail - forums - synchronous - chat - rooms - conferencing - media - computing - network - collaboration - smart - spaces - coordination - workflow - communities - characters - intelligent - agents - virtual - worlds - avatars - psychology - t - tests - anova - randomization - parametric - between - subjects - calculating - effect - size - exploratory - statistical - combining - result - applied - security - policies - economics - regulatory - responsibility - liability - self - determination - organizational - vulnerabilities - threats - pretext - impersonation - fraud - phishing - spear - ias - attacks - trust - privacy - deception - biometric - authentication - camera - voice - identity - intellectual - perspectives - technology - consideration - discipline - participatory - critically - reflective - critical - technical - practice - political - activism - philosophy - experience - ethnography - ethnomethodology - indicative - domains - application - sustainability - arts - informed - output - sound - stereoscopic - force - feedback - simulation - haptic - viewer - object - tracking - pose - gesture - accelerometers - fiducial - marker - issues - rendering - collision - detection - response - visibility - computation - time - multiple - levels - details - lod - architectures - game - engines - augmented - reality - flight - simulators - caves - medical - imaging - networking - p2p - client - server - dead - reckoning - encryption - synchronization - distributed</p>
7	IAS - Information Assurance and Security	<p>cia - confidentiality - integrity - availability - risk - threats - vulnerabilities - attack - vectors - cros - reference - se - software - project - management - authentication - authorization - access - control - mandatory - discretionary - trust - trustworthiness - ethics - responsible - disclosure - cross - sp - professional - accountability - responsibility - liability - least - privilege - isolation - os - security - protection - policy - mechanism - separation - sf - virtualization - rationale - predictable - performance - pl - language - translation - execution - memory - fail - safe - defaults - construction - coding - practices - techniques - idioms - patterns - mechanisms - building - quality - programs - sdf - development - programming - correctness - open - design - evolution - context - large - pre - existing - code - bases - end - reliability - through - redundancy -</p>

		<p>errors - increase - longer - distance - between - communicating - entities - principle - defense - depth - defensive - layered - system - principles - tensions - goals - complete - mediation - vetted - components - economy - reducing - trusted - computing - base - minimize - surface - green - field - usable - hci - foundations - cognitive - models - inform - interaction - composability - prevention - detection - deterrence - distinction - bugs - faults - nc - reliable - delivery - error - flow - input - validation - sanitization - choice - type - languages - examples - buffer - overflows - integer - sql - injection - xss - vulnerability - race - conditions - parallelism - parallel - pd - architecture - shared - distributed - communication - coordination - fundamentals - sequential - handling - exceptions - unexpected - behaviors - usage - third - party - operating - application - interfaces - apis - effectively - deploying - updates - devices - information - correctly - generating - randomness - purposes - detecting - mitigating - fuzzing - static - analysis - dynamic - verification - support - address - space - randomization - canaries - hardware - dep - tpm - attacker - capabilities - motivations - underground - digital - espionage - cyberwarfare - insider - hacktivism - advanced - persistent - malware - viruses - worms - spyware - botnets - trojan - horses - rootkits - denial - service - dos - ddos - social - engineering - phishing - implications - networked - world - designing - human - failure - attacks - privacy - anonymity - culture - networks - organizations - civil - liberties - technology - solutions - unwanted - covert - channels - steganography - network - specific - types - spoofing - sniffing - traffic - redirection - man - middle - message - routing - cryptography - architectures - secure - protocols - dns - vpns - anonymous - countermeasures - monitoring - intrusion - firewalls - honeypots - tracebacks - wireless - cellular - mobility - 802 - 11 - wired - ad - hoc - sensor - vehicular - censorship - resistance - operational - configure - basic - terminology - covering - notions - pertaining - different - partners - unsecure - channel - attackers - encryption - decryption - keys - characteristics - signatures - cipher - caesar - affine - together - typical - frequency - public - key - infrastructure - signature - challenges - elective - mathematical - preliminaries - essential - linear - algebra - number -</p>
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		<p>theory - probability - statistics - cryptographic - primitives - pseudo - random - generators - stream - ciphers - block - permutations - aes - function - hash - sha2 - collision - codes - derivations - symmetric - perfect - secrecy - one - time - pad - modes - operation - semantic - authenticated - encrypt - then - mac - ocb - gcm - cmac - hmac - trapdoor - permutation - rsa - ei - gamal - pki - certificates - hardness - assumptions - diffie - hellman - factoring - exchange - tls - challenge - response - zero - knowledge - commitment - oblivious - transfer - multi - computation - secret - sharing - applications - motivate - real - electronic - cash - clients - servers - mail - entity - device - pairing - voting - systems - definitions - indistinguishability - unforgeability - resistance - attacker - chosen - birthday - side - fault - standards - implementations - quantum - web - model - browser - origin - client - server - boundaries - rely - session - authentication - single - sign - https - defenses - csrf - cookies - http - extensions - hsts - plugins - apps - user - tracking - wafs - fuzzers - signing - boot - measured - root - attestation - co - processors - peripherals - dma - iommu - physical - trojans - probes - cold - embedded - medical - cars - path - legal - inference - controls - statistical - limitation - backup - password - refresh - breach - collection - retention - policies - supply - chain - cloud - tradeoffs - methodologies - forensics - forensic - needs - mind - rules - evidence - general - jurisdictions - custody - search - seizure - procedural - requirements - preservation - reporting - issues - working - expert - witness - file - mobile - investigation - anti - lifecycle - processes - specifications - testing - process - met - assurance - benchmarking - measurements</p>
8	IM - Information Management	<p>information - systems - socio - technical - basic - storage - retrieval - r - capture - representation - supporting - human - needs - searching - retrieving - linking - browsing - navigating - management - applications - declarative - navigational - queries - links - analysis - indexing - quality - issues - reliability - scalability - efficiency - effectiveness - approaches - evolution - database - components - design - core - dbms - function - query - mechanisms - transaction - buffer - access - architecture - independence - language - structured - stream - content - managing - large - volumes - nosql - mapreduce - modeling - conceptual - models - entity</p>

		<p>- relationship - uml - diagrams - spreadsheet - relational - object - cross - reference - pl - programming - semi - model - expressed - dtd - xml - schema - example - impact - indices - performance - structure - index - keeping - memory - indexes - sql - text - web - crawling - mapping - referential - integrity - algebra - calculus - functional - dependency - decomposition - lossless - join - preservation - properties - candidate - keys - superkeys - closure - set - attributes - normal - forms - bcnf - multi - valued - 4nf - pjnf - 5nf - theory - languages - formulation - update - sublanguage - constraints - selections - projections - select - project - aggregates - group - subqueries - qbe - 4th - generation - environments - different - ways - invoke - procedural - conventional - major - xpath - sparql - stored - procedures - transactions - failure - recovery - concurrency - control - interaction - especially - buffering - distributed - processing - homogeneous - heterogeneous - solutions - client - server - databases - sf - computational - paradigms - parallel - architectures - shared - disk - nothing - speedup - scale - up - cn - pd - replication - weak - consistency - file - indexed - files - hashed - signature - b - trees - dense - variable - length - records - tuning - uses - mining - algorithms - associative - sequential - patterns - clustering - market - basket - cleaning - visualization - gv - interactive - documents - electronic - publishing - markup - tries - inverted - pat - morphological - stemming - phrases - stop - lists - term - frequency - distributions - uncertainty - fuzziness - weighting - vector - space - probabilistic - logical - advanced - relevance - evaluation - thesauri - ontologies - classification - categorization - metadata - bibliographic - bibliometrics - citations - routing - community - filtering - multimedia - search - seeking - behavior - user - feedback - summarization - faceted - keywords - schemes - digital - libraries - digitization - interchange - objects - composites - packages - cataloging - naming - repositories - archives - archiving - spaces - geographical - 3d - vr - agents - buses - wrappers - mediators - interoperability - services - forth - intellectual - property - rights - privacy - protection - watermarking - input - output - devices - device - drivers - signals - protocols - dsps - standards - audio - graphics - video - media - editors - authoring - streams - structures - represent - transform - domains</p>
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		- compression - coding - images - animation - presentation - rendering - synchronization - modal - integration - interfaces - real - time - delivery - service - capacity - planning - conferencing - demand
9	IS - Intelligent Systems	ai - problems - examples - successful - recent - applications - what - intelligent - behavior - turing - test - rational - versus - reasoning - problem - characteristics - fully - partially - observable - single - multi - agent - deterministic - stochastic - static - dynamic - discrete - continuous - nature - agents - autonomous - semi - reflexive - goal - utility - importance - perception - environmental - interactions - philosophical - ethical - issues - spaces - states - goals - operators - solving - search - factored - representation - factoring - state - variables - uninformed - breadth - first - depth - iterative - deepening - heuristics - informed - hill - climbing - generic - space - time - efficiency - two - player - games - minimax - constraint - satisfaction - backtracking - local - review - propositional - predicate - logic - cross - reference - ds - basic - resolution - theorem - proving - forward - chaining - backward - probabilistic - bayes - probability - broad - variety - machine - learning - tasks - classification - inductive - simple - statistical - naive - bayesian - classifier - decision - trees - over - fitting - measuring - accuracy - constructing - combinatorial - explosion - simulated - annealing - genetic - algorithms - monte - carlo - tree - implementation - beam - alpha - beta - pruning - expectimax - mdp - chance - nodes - knowledge - description - logics - ontology - engineering - monotonic - classical - default - argumentation - about - action - change - situation - event - calculus - temporal - spatial - rule - expert - systems - semantic - networks - model - case - planning - partial - totally - ordered - plan - graphs - hierarchical - execution - conditional - mobile - random - distributions - axioms - inference - independence - representations - exact - complexity - randomized - sampling - gibbs - markov - relational - models - hidden - theory - preference - function - maximizing - architectures - reactive - layered - cognitive - rationality - game - theoretic - processes - software - personal - assistants - information - access - collaborative - gathering - believable - synthetic - characters - modeling - emotions - collaborating - teams - competitive - auctions - voting - swarm - biologically - inspired - grammars - parsing - cfgs -

		<p>chart - parsers - cyk - weighted - representing - meaning - semantics - roles - beliefs - desires - intentions - corpus - n - grams - hmms - smoothing - backoff - pos - tagging - morphology - retrieval - im - storage - vector - tf - idf - precision - recall - extraction - language - translation - text - categorization - bag - words - progress - art - robot - sensors - sensor - processing - control - deliberative - braitenberg - vehicles - world - inherent - uncertainty - sensing - configuration - maps - interpreting - uncertain - localizing - mapping - navigation - motion - multiple - coordination - vision - image - acquisition - properties - shape - object - recognition - segmentation - analysis - audio - speech - modularity - approaches - pattern - advanced - measures - quality - techniques</p>
10	NC - Networking and Communication	<p>organization - internet - service - providers - content - switching - techniques - circuit - packet - physical - pieces - network - hosts - routers - switches - isps - wireless - lan - access - point - firewalls - layering - principles - encapsulation - multiplexing - roles - different - layers - application - transport - datalink - naming - address - schemes - dns - ip - addresses - uniform - resource - identifiers - distributed - applications - client - server - peer - cloud - http - layer - protocol - tcp - udp - socket - apis - error - control - retransmission - timers - flow - acknowledgements - sliding - window - performance - issues - pipelining - routing - versus - forwarding - static - scalability - hierarchical - addressing - multiple - problem - common - approaches - exponential - backoff - time - division - local - area - networks - ethernet - need - allocation - fixed - tdm - fdm - wdm - dynamic - end - assisted - fairness - congestion - distribution - cellular - 802 - 11 - supporting - mobile - nodes - home - agents - social - example - platforms - structure - graphs - analysis - storage - file - indexed - files - hashed - signature - b - trees - dense - index - variable - length - records - database - efficiency - tuning - uses - mining - algorithms - associative - sequential - patterns - clustering - market - basket - cleaning - visualization - cross - reference - gv - cn - interactive - documents - electronic - publishing - markup - languages - tries - inverted - pat - indexing - morphological - stemming - phrases - stop - lists - term - frequency - distributions - uncertainty - fuzziness - weighting - vector - space - probabilistic - logical - advanced -</p>

		<p>models - information - needs - relevance - evaluation - effectiveness - thesauri - ontologies - classification - categorization - metadata - bibliographic - bibliometrics - citations - community - filtering - multimedia - search - seeking - behavior - user - modeling - feedback - summarization - faceted - keywords - digital - libraries - digitization - interchange - objects - composites - packages - cataloging - repositories - archives - archiving - preservation - integrity - spaces - conceptual - geographical - 3d - vr - architectures - buses - wrappers - mediators - interoperability - services - searching - linking - browsing - forth - intellectual - property - rights - management - privacy - protection - watermarking - input - output - devices - device - drivers - signals - protocols - dsp - standards - audio - graphics - video - media - editors - authoring - systems - streams - structures - capture - represent - transform - domains - compression - coding - retrieval - images - animation - presentation - rendering - synchronization - multi - modal - integration - interfaces - real - delivery - quality - capacity - planning - conferencing - demand</p>
11	OS - Operating Systems	<p>role - purpose - operating - system - functionality - typical - mechanisms - support - client - server - models - hand - held - devices - design - issues - efficiency - robustness - flexibility - portability - security - compatibility - influences - networking - multimedia - windowing - systems - structuring - monolithic - layered - modular - micro - kernel - abstractions - processes - resources - application - interfaces - apis - evolution - hardware - software - techniques - needs - device - organization - interrupts - implementations - user - state - protection - transition - mode - states - diagrams - cross - reference - sf - machines - structures - ready - list - process - control - blocks - forth - dispatching - context - switching - managing - atomic - access - os - objects - implementing - synchronization - primitives - multiprocessor - spin - locks - reentrancy - parallelism - preemptive - scheduling - resource - allocation - pd - parallel - performance - schedulers - policies - threads - computational - paradigms - deadlines - real - time - review - physical - memory - management - working - sets - thrashing - caching - ar - architecture - policy - mechanism - separation - authentication - backups - types - virtualization - service - network - paging - virtual - file -</p>

		hypervisors - portable - emulation - isolation - cost - characteristics - serial - abstracting - buffering - strategies - direct - recovery - failures - files - metadata - operations - sequential - nonsequential - directories - contents - structure - partitioning - mount - unmount - standard - implementation - mapped - special - naming - searching - journaling - log - structured - task - disk - requirements - environment - risks - concerns - fundamental - reliable - available - reliability - through - redundancy - spatial - temporal - used - implement - fault - tolerance - examples - detection - restart - these - own - services - be - evaluated - figures - merit - what - evaluation - deterministic - analytic - simulation - specific - collect - profiling - tracing
12	PBD - Platform-Based Development	platforms - web - mobile - game - industrial - programming - platform - specific - apis - languages - objective - c - html5 - under - constraints - java - script - php - css - software - service - saas - standards - states - state - diagrams - cross - reference - sf - machines - structures - ready - list - process - control - blocks - forth - dispatching - context - switching - role - interrupts - managing - atomic - access - os - objects - implementing - synchronization - primitives - multiprocessor - issues - spin - locks - reentrancy - parallelism - types - mathematic - robotic - architecture - domain - xbox - wii - playstation - lua - python
13	PD - Parallel and Distributed Computing	multiple - simultaneous - computations - goals - parallelism - throughput - versus - concurrency - controlling - access - shared - resources - communication - coordination - programming - constructs - coordinating - need - synchronization - errors - sequential - races - read - write - state - higher - level - interleavings - violating - intention - undesired - determinism - lack - liveness - progress - deadlock - starvation - independence - partitioning - basic - knowledge - parallel - decomposition - cross - reference - sf - system - support - task - implementation - strategies - threads - simd - mapreduce - actors - reactive - processes - request - handlers - memory - consistency - role - language - guarantees - race - programs - message - passing - point - multicast - event - messages - blocking - styles - sending - receiving - buffering - pf - fundamental - structures - queues - atomicity - specifying - testing - safety - requirements - granularity - atomic - accesses - updates - critical -

		<p>sections - transactions - describe - mutual - exclusion - locks - semaphores - monitors - related - potential - failures - causes - conditions - prevention - composition - composing - larger - actions - optimistic - conservative - approaches - consensus - cyclic - barriers - counters - conditional - waiting - condition - variables - paths - work - span - relation - amdahl - law - performance - speed - up - scalability - naturally - embarrassingly - algorithms - algorithmic - patterns - divide - conquer - map - reduce - master - workers - others - specific - mergesort - graph - shortest - path - spanning - tree - al - matrix - producer - consumer - pipelined - examples - scalable - multicore - processors - distributed - symmetric - multiprocessing - smp - vector - processing - gpu - co - flynn - taxonomy - instruction - instructions - compare - set - issues - multiprocessor - caches - cache - coherence - uniform - numa - topologies - interconnects - clusters - resource - sharing - buses - load - balancing - measurement - scheduling - contention - os - dispatch - evaluating - overhead - management - costs - due - proximity - effects - false - maintaining - spatial - locality - power - usage - faults - fault - tolerance - network - partitions - node - impact - wide - availability - conversion - transmission - sockets - sequencing - retrying - dropping - design - tradeoffs - latency - partition - service - stateful - stateless - protocols - services - session - connection - designs - io - triggered - multithreaded - core - election - discovery - internet - scale - computing - pd - analysis - grids - meshes - cloud - infrastructure - elasticity - platform - apis - software - security - cost - virtualization - isolation - virtual - machines - migration - storage - weakly - consistent - stores - file - systems - im - databases - replication - formal - models - algebras - communicating - csp - pi - calculus - computation - random - machine - pram - alternatives - bulk - synchronous - bsp - computational - dependencies - relaxed - specifications - correctness - criteria - linearizability - fairness - techniques - checking - properties - freedom</p>
14	PL - Programming Languages	<p>object - design - decomposition - objects - carrying - state - having - behavior - class - hierarchy - modeling - classes - fields - constructors - subclasses - inheritance - overriding - dynamic - dispatch - call - subtyping - cross - reference - pl - type - systems -</p>

		<p> subtype - polymorphism - implicit - upcasts - typed - languages - notion - behavioral - replacement - subtypes - acting - supertypes - relationship - between - idioms - encapsulation - privacy - visibility - members - interfaces - revealing - signatures - abstract - base - collection - iterators - common - library - components - effect - programming - function - calls - side - effects - facilitating - compositional - reasoning - variables - immutable - preventing - unexpected - changes - code - freely - aliased - copied - without - introducing - unintended - mutation - processing - structured - trees - cases - variant - associated - language - constructs - discriminated - unions - pattern - matching - over - compound - terms - applied - constituent - pieces - first - taking - returning - storing - closures - enclosing - lexical - environment - basic - meaning - run - time - capturing - canonical - backs - arguments - reusable - closure - encapsulate - currying - partial - application - defining - higher - order - operations - aggregates - especially - map - reduce - fold - filter - events - event - handlers - uses - guis - mobile - devices - robots - servers - reactive - framework - listeners - main - loop - under - handler - writer - control - externally - generated - separation - model - view - controller - set - values - together - primitive - types - numbers - booleans - built - records - arrays - lists - association - results - safety - errors - inconsistently - intended - goals - limitations - static - typing - eliminating - running - undecidability - analysis - must - conservatively - approximate - generic - parametric - libraries - collections - comparison - ad - hoc - overloading - complementary - benefits - early - late - avoided - enforce - invariants - during - development - maintenance - postpone - decisions - while - prototyping - conveniently - allow - flexible - coding - patterns - heterogeneous - avoid - misuse - reuse - detect - incomplete - programs - input - interpreters - compilers - checkers - documentation - generators - syntax - contrast - concrete - structures - represent - execution - translation - transmission - interpretation - compilation - native - portable - intermediate - representation - pipeline - parsing - optional - checking - linking - virtual - machine - alternatives - loading - generation - core - tables - layout - memory - stack - heap - implementing - loops - recursion - tail - management - manual - </p>
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		<p>allocating - de - reusing - automated - garbage - technique - reachability - scanning - regular - expressions - strategies - top - down - recursive - descent - earley - ll - bottom - up - backtracking - lr - techniques - role - context - grammars - generating - scanners - parsers - declarative - specifications - high - level - representations - scope - binding - resolution - attribute - procedure - dispatching - separate - instruction - selection - scheduling - register - allocation - peephole - optimization - approaches - malloc - mark - sweep - copying - counting - regions - known - arenas - zones - activation - recompilation - features - machines - threads - security - relevant - blocks - flow - graphs - def - chains - single - assignment - consequences - insensitive - analyses - scalable - pointer - alias - sensitive - forward - backward - dataflow - path - software - frameworks - verification - bug - finding - lazy - evaluation - infinite - streams - abstractions - exception - handling - continuations - monads - multiple - mixins - traits - multimethods - metaprogramming - macros - generative - module - string - manipulation - eval - support - assertions - pre - post - conditions - thread - shared - synchronization - actor - models - futures - parallelism - passing - messages - sequential - processes - consistency - semantics - product - sum - quantified - preservation - plus - progress - inference - lambda - calculus - operational - denotational - axiomatic - proofs - induction - formal - s - parametricity - principles - orthogonality - precedence - associativity - eager - delayed - iteration - external - system - clausal - algorithms - unification - search - cuts</p>
15	SDF - Software Development Fundamentals	<p>properties - algorithms - informal - comparison - algorithm - efficiency - operation - counts - role - problem - solving - process - strategies - iterative - recursive - mathematical - function - traversal - structures - divide - conquer - fundamental - design - principles - abstraction - decomposition - encapsulation - information - hiding - separation - behavior - implementation - basic - syntax - semantics - higher - level - language - variables - primitive - types - numbers - characters - booleans - expressions - assignments - simple - o - file - conditional - control - parameter - passing - recursion - arrays - records - structs - heterogeneous - aggregates - strings - string - processing - abstract - stacks - queues - priority - sets - maps - reference -</p>

		aliasing - linked - lists - choosing - appropriate - structure - comprehension - correctness - errors - logic - run - time - specification - defensive - programming - secure - coding - exception - handling - code - reviews - testing - fundamentals - test - case - generation - contracts - pre - post - conditions - unit - refactoring - modern - environments - search - library - components - apis - debugging - documentation - style
16	SE - Software Engineering	systems - level - considerations - interaction - software - intended - environment - crossreference - ias - secure - engineering - process - models - waterfall - incremental - agile - activities - lifecycles - programming - large - individual - evaluation - quality - improvement - capability - maturity - measurements - team - participation - processes - responsibilities - tasks - meeting - structure - work - schedule - roles - conflict - resolution - risks - associated - virtual - teams - communication - perception - effort - estimation - personal - risk - cross - reference - role - lifecycle - categories - security - safety - market - financial - technology - people - management - organization - decision - making - identification - assignment - performance - assessment - project - scheduling - tracking - cost - benefit - analysis - measurement - techniques - assurance - tolerance - adverse - neutral - seeking - planning - system - wide - approach - hazards - configuration - version - control - release - requirements - design - modeling - testing - static - dynamic - environments - automate - parts - construction - automated - builds - continuous - integration - tool - mechanisms - describing - functional - example - cases - users - stories - properties - consistency - validity - completeness - feasibility - elicitation - class - diagrams - entity - relationship - specifications - acceptability - certainty - uncertainty - regarding - behavior - prototyping - basic - formal - specification - validation - tracing - concerns - information - hiding - coupling - cohesion - standard - structures - paradigms - structured - top - down - decomposition - object - event - driven - component - centered - aspect - function - service - structural - behavioral - designs - patterns - relationships - between - transformation - contracts - invariants - architecture - architectures - client - server - n - layer - transform - pipes - filters - refactoring - components - selection - adaptation -

		<p>assembly - objects - building - gui - widget - set - internal - qualities - efficiency - redundancy - fault - traceability - external - functionality - reliability - usability - maintainability - portability - tradeoffs - different - aspects - application - frameworks - middleware - paradigm - request - brokers - marshalling - transaction - processing - monitors - workflow - principles - coding - principle - least - privilege - fail - safe - defaults - psychological - practices - idioms - programs - defensive - sdf - development - exception - handling - make - robust - tolerant - standards - strategies - context - green - field - existing - code - base - change - impact - actualization - potential - problems - buffer - types - overflows - race - conditions - improper - initialization - choice - privileges - checking - input - assuming - success - correctness - validating - assumptions - verification - inspections - reviews - audits - human - interface - conformance - fundamentals - unit - test - plan - creation - case - generation - black - box - white - regression - automation - defect - limitations - particular - domains - parallel - critical - approaches - documentation - artifacts - help - files - training - materials - logging - technical - support - termination - seeding - pre - bases - concern - location - evolution - characteristics - maintainable - reengineering - reuse - segments - libraries - product - lines - failure - sf - through - cycle - assertion - languages - writing - analyzing - preand - post - ocl - jml - model - checkers - finders</p>
17	SF - System Fundamental	<p>basic - building - blocks - components - gates - flip - flops - registers - interconnections - datapath - control - memory - hardware - computational - paradigm - fundamental - logic - expressions - minimization - sum - product - forms - application - level - sequential - processing - single - thread - simple - parallel - request - web - services - client - server - distributed - per - multiple - threads - servers - pipelining - overlapped - stages - scaling - going - faster - handling - larger - problems - programming - abstractions - interfaces - libraries - distinction - between - os - remote - procedure - call - virtual - machine - interaction - reliability - digital - analog - discrete - continuous - systems - logical - boolean - simplification - clocks - state - sequencing - combinational - memories - computers - network - protocols - examples - machines - concurrent -</p>

		<p>parallelism - task - fork - join - multicore - architectures - support - synchronization - performance - figures - merit - workloads - representative - benchmarks - collecting - analyzing - cpi - cycles - instruction - equation - tool - understanding - tradeoffs - design - sets - processor - pipelines - system - organizations - amdahl - law - part - computation - sped - up - limits - effect - parts - kinds - resources - share - disk - net - bandwidth - scheduling - first - come - priority - advantages - fair - preemptive - speed - light - one - foot - nanosecond - ghz - latencies - across - caches - effects - spatial - temporal - locality - processors - cache - coherency - databases - operating - architecture - hierarchy - formula - average - access - time - rationale - protection - predictable - levels - indirection - illustrated - managing - physical - implementing - bugs - faults - redundancy - through - check - retry - redundant - encoding - error - correcting - codes - crc - fec - duplication - mirroring - replicas - approaches - fault - tolerance - availability - analytical - guide - quantitative - evaluation - order - magnitude - analysis - big - oh - notation - slow - fast - paths - events - stalls - misses - page - layered - platforms - implications - challenges - represent - microbenchmarking - pitfalls</p>
18	SP - Social Issues and Professional Practice	<p>social - implications - computing - networked - world - cross - reference - hci - foundations - models - ias - fundamental - issues - impact - media - individualism - collectivism - culture - growth - control - internet - nc - organization - often - referred - digital - divide - access - technology - resources - resulting - ramifications - gender - class - ethnicity - geography - underdeveloped - countries - accessibility - legal - requirements - context - aware - design - mouse - interfaces - ubiquitous - contextaware - ethical - argumentation - theories - decision - making - moral - assumptions - values - community - laws - which - live - nature - professionalism - care - attention - discipline - fiduciary - responsibility - mentoring - keeping - up - date - professional - terms - familiarity - skills - framework - well - ability - self - assess - progress - field - certification - codes - ethics - conduct - practice - acm - ieee - cs - se - aitp - ifip - international - societies - accountability - liability - software - correctness - reliability - safety - confidentiality - cybersecurity - professionals - role -</p>

		<p>public - policy - maintaining - awareness - consequences - dissent - whistle - blowing - relationship - between - regional - dilemmas - dealing - harassment - discrimination - forms - credentialing - acceptable - policies - workplace - ergonomics - healthy - environments - time - market - cost - considerations - versus - quality - standards - philosophical - intellectual - property - rights - im - information - storage - retrieval - protection - intangible - idip - management - copyrights - patents - trade - secrets - trademarks - plagiarism - open - source - movement - piracy - privacy - widespread - collection - transactional - databases - warehouses - surveillance - systems - cloud - database - independence - mining - cleaning - differential - solutions - threats - attacks - anonymity - legislation - areas - civil - liberties - cultural - freedom - expression - limitations - reading - understanding - summarizing - technical - material - code - documentation - writing - effective - materials - dynamics - oral - written - electronic - team - group - communication - collaboration - project - participation - communicating - professionally - stakeholders - utilizing - online - communities - agents - collaborative - user - centered - testing - crosscultural - evaluation - tradeoffs - competing - risks - projects - structure - process - people - financial - risk - being - sustainable - practitioner - taking - consideration - environmental - impacts - implementation - decisions - organizational - economic - viability - resource - consumption - explore - global - disposal - waste - choices - specific - algorithms - operating - networks - human - interaction - evolution - sustainability - guidelines - systemic - effects - complex - mediated - phenomena - telecommuting - web - shopping - pervasive - processing - integrated - everyday - objects - activities - smart - energy - networking - feedback - promote - behavior - transportation - monitoring - citizen - science - activism - research - applications - pollution - usage - recycling - reuse - food - farming - others - interdependence - knowledge - users - processes - societal - forces - government - prehistory - before - 1946 - history - hardware - ar - logic - architecture - pioneers - monopolies - effect - skilled - labor - supply - demand - products - pricing - strategies - domain - phenomenon - outsourcing - off - shoring - development - employment -</p>
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	<p>economics - globalization - profession - possible - thereof - benefit - analysis - jobs - manufacturing - engineering - estimates - actual - costs - relation - total - entrepreneurship - prospects - pitfalls - network - side - economies - scale - finances - examples - crimes - redress - criminals - forensics - rules - evidence - identity - theft - recovery - factors - security - trust - deception - surrounding - misuse - breaches - motivations - cyber - terrorism - criminal - hacking - cracking - malware - viruses - worms - trojan - horses - crime - prevention - governance</p>
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Appendix 3

Subject Probability to The Knowledge Area

Subject	Knowledge Area	Probability
1565001 Foundation of Computing	AL - Algorithms and Complexity	1.60419270661286e-32
	AR - Architecture and Organization	1.60419270661286e-32
	CN - Computational Science	8.213466657857843e-30
	DS - Discrete Structures	1.60419270661286e-32
	GV - Graphics and Visualization	2.566708330580576e-31
	HCI - Human-Computer Interaction	8.213466657857843e-30
	IAS - Information Assurance and Security	8.213466657857843e-30
	IM - Information Management	2.566708330580576e-31
	IS - Intelligent Systems	2.0533666644644607e-30
	NC - Networking and Communications	1.283354165290288e-31
	OS - Operating Systems	6.41677082645144e-32
	PBD - Platform-based Development	1.60419270661286e-32
	PD - Parallel and Distributed Computing	5.133416661161152e-31
	PL - Programming Languages	2.566708330580576e-31
	SDF - Software Development Fundamental	6.41677082645144e-32
SE - Software Engineering	2.0533666644644607e-30	
SF - Systems Fundamentals	1.0266833322322304e-30	
SP - Social Issues and Professional Practice	8.213466657857843e-30	

Subject	Knowledge Area	Probability
1565002 Calculus	AL - Algorithms and Complexity	2.3354654084403535e-21
	AR - Architecture and Organization	-
	CN - Computational Science	1.4946978614018262e-19
	DS - Discrete Structures	4.670930816880707e-21
	GV - Graphics and Visualization	3.7367446535045656e-20
	HCI - Human-Computer Interaction	4.670930816880707e-21
	IAS - Information Assurance and Security	1.8683723267522828e-20
	IM - Information Management	9.341861633761414e-21
	IS - Intelligent Systems	9.341861633761414e-21

	NC - Networking and Communications	4.670930816880707e-21
	OS - Operating Systems	2.3354654084403535e-21
	PBD - Platform-based Development	
	PD - Parallel and Distributed Computing	2.3354654084403535e-21
	PL - Programming Languages	9.341861633761414e-21
	SDF - Software Development Fundamental	2.3354654084403535e-21
	SE - Software Engineering	4.670930816880707e-21
	SF - Systems Fundamentals	2.3354654084403535e-21
	SP - Social Issues and Professional Practice	1.8683723267522828e-20

Subject	Knowledge Area	Probability
1565003 Algorithm & Programming 1	AL - Algorithms and Complexity	1.338514568535419e-25
	AR - Architecture and Organization	1.338514568535419e-25
	CN - Computational Science	3.3462864213385476e-26
	DS - Discrete Structures	1.338514568535419e-25
	GV - Graphics and Visualization	1.6731432106692738e-26
	HCI - Human-Computer Interaction	8.365716053346369e-27
	IAS - Information Assurance and Security	6.692572842677095e-26
	IM - Information Management	6.692572842677095e-26
	IS - Intelligent Systems	3.3462864213385476e-26
	NC - Networking and Communications	1.6731432106692738e-26
	OS - Operating Systems	8.365716053346369e-27
	PBD - Platform-based Development	8.365716053346369e-27
	PD - Parallel and Distributed Computing	1.6731432106692738e-26
	PL - Programming Languages	5.354058274141676e-25
	SDF - Software Development Fundamental	5.354058274141676e-25
	SE - Software Engineering	3.3462864213385476e-26
	SF - Systems Fundamentals	6.692572842677095e-26
SP - Social Issues and Professional Practice	3.3462864213385476e-26	

Subject	Knowledge Area	Probability
1565004 Discrete Mathematics	AL - Algorithms and Complexity	2.0846098953618713e-55
	AR - Architecture and Organization	2.5446898136741594e-59
	CN - Computational Science	3.257202961502924e-57
	DS - Discrete Structures	1.0423049476809357e-55
	GV - Graphics and Visualization	3.257202961502924e-57
	HCI - Human-Computer Interaction	2.5446898136741594e-59
	IAS - Information Assurance and Security	2.605762369202339e-56
	IM - Information Management	6.514405923005848e-57
	IS - Intelligent Systems	3.257202961502924e-57
	NC - Networking and Communications	4.071503701878655e-58
	OS - Operating Systems	2.5446898136741594e-59
	PBD - Platform-based Development	1.2723449068370797e-59
	PD - Parallel and Distributed Computing	2.0357518509393275e-58
	PL - Programming Languages	3.257202961502924e-57
	SDF - Software Development Fundamental	8.14300740375731e-58
	SE - Software Engineering	8.14300740375731e-58
SF - Systems Fundamentals	8.14300740375731e-58	
SP - Social Issues and Professional Practice	1.0178759254696637e-58	

Subject	Knowledge Area	Probability
1565005 Linear Algebra	AL - Algorithms and Complexity	1.6285027057572455e-9
	AR - Architecture and Organization	1.6285027057572455e-9
	CN - Computational Science	6.514010823028982e-9
	DS - Discrete Structures	-
	GV - Graphics and Visualization	3.257005411514491e-9
	HCI - Human-Computer Interaction	-
	IAS - Information Assurance and Security	1.6285027057572455e-9
	IM - Information Management	1.6285027057572455e-9
	IS - Intelligent Systems	1.6285027057572455e-9

	NC - Networking and Communications	1.6285027057572455e-9
	OS - Operating Systems	-
	PBD - Platform-based Development	-
	PD - Parallel and Distributed Computing	3.257005411514491e-9
	PL - Programming Languages	-
	SDF - Software Development Fundamental	-
	SE - Software Engineering	-
	SF - Systems Fundamentals	1.6285027057572455e-9
	SP - Social Issues and Professional Practice	-

Subject	Knowledge Area	Probability
1565006 Data Structure	AL - Algorithms and Complexity	1.4699847330891425e-44
	AR - Architecture and Organization	3.674961832722856e-45
	CN - Computational Science	1.4699847330891425e-44
	DS - Discrete Structures	7.349923665445712e-45
	GV - Graphics and Visualization	1.837480916361428e-45
	HCI - Human-Computer Interaction	4.59370229090357e-46
	IAS - Information Assurance and Security	2.939969466178285e-44
	IM - Information Management	5.87993893235657e-44
	IS - Intelligent Systems	3.674961832722856e-45
	NC - Networking and Communications	7.349923665445712e-45
	OS - Operating Systems	7.349923665445712e-45
	PBD - Platform-based Development	2.296851145451785e-46
	PD - Parallel and Distributed Computing	7.349923665445712e-45
	PL - Programming Languages	5.87993893235657e-44
	SDF - Software Development Fundamental	9.18740458180714e-46
	SE - Software Engineering	9.18740458180714e-46
SF - Systems Fundamentals	9.18740458180714e-46	
SP - Social Issues and Professional Practice	1.837480916361428e-45	

Subject	Knowledge Area	Probability
	AL - Algorithms and Complexity	8.848615630926263e-27

1565007 Algorithm & Programming 2	AR - Architecture and Organization	-
	CN - Computational Science	1.7282452404152858e-29
	DS - Discrete Structures	2.1603065505191073e-30
	GV - Graphics and Visualization	2.1603065505191073e-30
	HCI - Human-Computer Interaction	2.1603065505191073e-30
	IAS - Information Assurance and Security	4.3206131010382145e-30
	IM - Information Management	8.641226202076429e-30
	IS - Intelligent Systems	2.7651923846644573e-28
	NC - Networking and Communications	8.641226202076429e-30
	OS - Operating Systems	1.0801532752595536e-30
	PBD - Platform-based Development	-
	PD - Parallel and Distributed Computing	8.641226202076429e-30
	PL - Programming Languages	3.4564904808305716e-29
	SDF - Software Development Fundamental	8.641226202076429e-30
	SE - Software Engineering	2.1603065505191073e-30
SF - Systems Fundamentals	2.1603065505191073e-30	
SP - Social Issues and Professional Practice	4.3206131010382145e-30	

Subject	Knowledge Area	Probability
1565009 Statistics	AL - Algorithms and Complexity	1.513321629541895e-42
	AR - Architecture and Organization	-
	CN - Computational Science	2.421314607267032e-41
	DS - Discrete Structures	2.421314607267032e-41
	GV - Graphics and Visualization	2.421314607267032e-41
	HCI - Human-Computer Interaction	6.05328651816758e-42
	IAS - Information Assurance and Security	3.02664325908379e-42
	IM - Information Management	3.02664325908379e-42
	IS - Intelligent Systems	3.02664325908379e-42
	NC - Networking and Communications	3.02664325908379e-42

	OS - Operating Systems	7.566608147709474e-43
	PBD - Platform-based Development	-
	PD - Parallel and Distributed Computing	1.513321629541895e-42
	PL - Programming Languages	7.566608147709474e-43
	SDF - Software Development Fundamental	7.566608147709474e-43
	SE - Software Engineering	6.05328651816758e-42
	SF - Systems Fundamentals	7.566608147709474e-43
	SP - Social Issues and Professional Practice	7.566608147709474e-43

Subject	Knowledge Area	Probability
1565010 Object Oriented Programming	AL - Algorithms and Complexity	6.676929387618025e-30
	AR - Architecture and Organization	1.6692323469045063e-30
	CN - Computational Science	3.3384646938090126e-30
	DS - Discrete Structures	1.6692323469045063e-30
	GV - Graphics and Visualization	1.6692323469045063e-30
	HCI - Human-Computer Interaction	6.676929387618025e-30
	IAS - Information Assurance and Security	1.335385877523605e-29
	IM - Information Management	1.335385877523605e-29
	IS - Intelligent Systems	6.676929387618025e-30
	NC - Networking and Communications	2.67077175504721e-29
	OS - Operating Systems	1.6692323469045063e-30
	PBD - Platform-based Development	1.6692323469045063e-30
	PD - Parallel and Distributed Computing	1.6692323469045063e-30
	PL - Programming Languages	1.7092939232302144e-27
	SDF - Software Development Fundamental	5.34154351009442e-29
SE - Software Engineering	5.34154351009442e-29	
SF - Systems Fundamentals	3.3384646938090126e-30	
SP - Social Issues and Professional Practice	3.3384646938090126e-30	

Subject	Knowledge Area	Probability
1565011 Database	AL - Algorithms and Complexity	7.225988047882043e-32
	AR - Architecture and Organization	1.4451976095764086e-31
	CN - Computational Science	1.4451976095764086e-31
	DS - Discrete Structures	-
	GV - Graphics and Visualization	7.225988047882043e-32
	HCI - Human-Computer Interaction	2.890395219152817e-31
	IAS - Information Assurance and Security	9.249264701289015e-30
	IM - Information Management	3.699705880515606e-29
	IS - Intelligent Systems	5.780790438305634e-31
	NC - Networking and Communications	2.890395219152817e-31
	OS - Operating Systems	1.1561580876611269e-30
	PBD - Platform-based Development	1.4451976095764086e-31
	PD - Parallel and Distributed Computing	2.890395219152817e-31
	PL - Programming Languages	2.890395219152817e-31
	SDF - Software Development Fundamental	3.6129940239410215e-32
SE - Software Engineering	2.3123161753222538e-30	
SF - Systems Fundamentals	5.780790438305634e-31	
SP - Social Issues and Professional Practice	2.3123161753222538e-30	

Subject	Knowledge Area	Probability
1565012 Computer System	AL - Algorithms and Complexity	2.0021235282111896e-40
	AR - Architecture and Organization	6.406795290275807e-39
	CN - Computational Science	8.008494112844759e-40
	DS - Discrete Structures	-
	GV - Graphics and Visualization	2.0021235282111896e-40
	HCI - Human-Computer Interaction	3.2033976451379034e-39
	IAS - Information Assurance and Security	2.5627181161103227e-38
	IM - Information Management	8.008494112844759e-40

	IS - Intelligent Systems	2.0021235282111896e-40
	NC - Networking and Communications	4.004247056422379e-40
	OS - Operating Systems	1.6016988225689517e-39
	PBD - Platform-based Development	-
	PD - Parallel and Distributed Computing	3.2033976451379034e-39
	PL - Programming Languages	1.6016988225689517e-39
	SDF - Software Development Fundamental	4.004247056422379e-40
	SE - Software Engineering	1.6016988225689517e-39
	SF - Systems Fundamentals	4.004247056422379e-40
	SP - Social Issues and Professional Practice	4.004247056422379e-40

Subject	Knowledge Area	Probability
1565013 Numerical Methods	AL - Algorithms and Complexity	-
	AR - Architecture and Organization	-
	CN - Computational Science	1.34910242164948e-39
	DS - Discrete Structures	-
	GV - Graphics and Visualization	5.269931334568281e-42
	HCI - Human-Computer Interaction	-
	IAS - Information Assurance and Security	-
	IM - Information Management	2.6349656672841406e-42
	IS - Intelligent Systems	2.6349656672841406e-42
	NC - Networking and Communications	2.6349656672841406e-42
	OS - Operating Systems	-
	PBD - Platform-based Development	-
	PD - Parallel and Distributed Computing	5.269931334568281e-42
	PL - Programming Languages	2.6349656672841406e-42
SDF - Software Development Fundamental	-	
SE - Software Engineering	2.6349656672841406e-42	
SF - Systems Fundamentals	-	

	SP - Social Issues and Professional Practice	2.6349656672841406e-42
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Subject	Knowledge Area	Probability
1565014 Web Programming	AL - Algorithms and Complexity	-
	AR - Architecture and Organization	-
	CN - Computational Science	-
	DS - Discrete Structures	-
	GV - Graphics and Visualization	-
	HCI - Human-Computer Interaction	-
	IAS - Information Assurance and Security	-
	IM - Information Management	1.246484794463557e-10
	IS - Intelligent Systems	-
	NC - Networking and Communications	-
	OS - Operating Systems	-
	PBD - Platform-based Development	9.971878355708455e-10
	PD - Parallel and Distributed Computing	-
	PL - Programming Languages	1.246484794463557e-10
	SDF - Software Development Fundamental	-
SE - Software Engineering	-	
SF - Systems Fundamentals	-	
SP - Social Issues and Professional Practice	1.246484794463557e-10	

Subject	Knowledge Area	Probability
1565015 - Software Engineering	AL - Algorithms and Complexity	3.0009830420634856e-34
	AR - Architecture and Organization	7.502457605158714e-35
	CN - Computational Science	4.801572867301577e-33
	DS - Discrete Structures	1.8756144012896785e-35
	GV - Graphics and Visualization	1.5004915210317428e-34
	HCI - Human-Computer Interaction	7.682516587682523e-32
	IAS - Information Assurance and Security	7.682516587682523e-32
	IM - Information Management	9.603145734603154e-33
	IS - Intelligent Systems	3.0009830420634856e-34

	NC - Networking and Communications	7.502457605158714e-35
	OS - Operating Systems	3.0009830420634856e-34
	PBD - Platform-based Development	7.502457605158714e-35
	PD - Parallel and Distributed Computing	3.0009830420634856e-34
	PL - Programming Languages	4.801572867301577e-33
	SDF - Software Development Fundamental	3.0009830420634856e-34
	SE - Software Engineering	3.0730066350730093e-31
	SF - Systems Fundamentals	7.502457605158714e-35
	SP - Social Issues and Professional Practice	9.603145734603154e-33

Subject	Knowledge Area	Probability
1565016 - Computer Graphic	AL - Algorithms and Complexity	3.6756087604710936e-24
	AR - Architecture and Organization	3.6756087604710936e-24
	CN - Computational Science	5.88097401675375e-23
	DS - Discrete Structures	7.351217520942187e-24
	GV - Graphics and Visualization	2.3523896067015e-22
	HCI - Human-Computer Interaction	1.17619480335075e-22
	IAS - Information Assurance and Security	7.351217520942187e-24
	IM - Information Management	2.3523896067015e-22
	IS - Intelligent Systems	1.4702435041884375e-23
	NC - Networking and Communications	2.940487008376875e-23
	OS - Operating Systems	3.6756087604710936e-24
	PBD - Platform-based Development	3.6756087604710936e-24
	PD - Parallel and Distributed Computing	3.6756087604710936e-24
	PL - Programming Languages	5.88097401675375e-23
SDF - Software Development Fundamental	3.6756087604710936e-24	
SE - Software Engineering	5.88097401675375e-23	
SF - Systems Fundamentals	3.6756087604710936e-24	

	SP - Social Issues and Professional Practice	7.351217520942187e-24
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Subject	Knowledge Area	Probability
1565017 - Computer Network	AL - Algorithms and Complexity	1.3965714281296381e-67
	AR - Architecture and Organization	5.5862857125185525e-67
	CN - Computational Science	5.5862857125185525e-67
	DS - Discrete Structures	-
	GV - Graphics and Visualization	8.938057140029684e-66
	HCI - Human-Computer Interaction	8.938057140029684e-66
	IAS - Information Assurance and Security	1.1440713139237995e-63
	IM - Information Management	4.469028570014842e-66
	IS - Intelligent Systems	-
	NC - Networking and Communications	1.8305141022780793e-62
	OS - Operating Systems	8.938057140029684e-66
	PBD - Platform-based Development	5.5862857125185525e-67
	PD - Parallel and Distributed Computing	5.5862857125185525e-67
	PL - Programming Languages	1.3965714281296381e-67
	SDF - Software Development Fundamental	-
SE - Software Engineering	1.1172571425037105e-66	
SF - Systems Fundamentals	4.469028570014842e-66	
SP - Social Issues and Professional Practice	4.469028570014842e-66	

Subject	Knowledge Area	Probability
1565018 - Artificial Intelligence	AL - Algorithms and Complexity	1.1884626037588367e-28
	AR - Architecture and Organization	2.971156509397092e-29
	CN - Computational Science	1.1884626037588367e-28
	DS - Discrete Structures	2.3769252075176734e-28
	GV - Graphics and Visualization	4.753850415035347e-28
	HCI - Human-Computer Interaction	2.3769252075176734e-28

	IAS - Information Assurance and Security	1.1884626037588367e-28
	IM - Information Management	2.971156509397092e-29
	IS - Intelligent Systems	3.042464265622622e-26
	NC - Networking and Communications	2.971156509397092e-29
	OS - Operating Systems	5.942313018794183e-29
	PBD - Platform-based Development	-
	PD - Parallel and Distributed Computing	1.1884626037588367e-28
	PL - Programming Languages	4.753850415035347e-28
	SDF - Software Development Fundamental	1.1884626037588367e-28
	SE - Software Engineering	1.1884626037588367e-28
	SF - Systems Fundamentals	1.1884626037588367e-28
	SP - Social Issues and Professional Practice	5.942313018794183e-29

Subject	Knowledge Area	Probability
1565019 - Computer Vision	AL - Algorithms and Complexity	2.681749056326802e-68
	AR - Architecture and Organization	1.6760931602042511e-69
	CN - Computational Science	6.865277584196613e-66
	DS - Discrete Structures	3.3521863204085023e-69
	GV - Graphics and Visualization	2.746111033678645e-65
	HCI - Human-Computer Interaction	3.4326387920983063e-66
	IAS - Information Assurance and Security	2.1453992450614415e-67
	IM - Information Management	1.0726996225307207e-67
	IS - Intelligent Systems	1.098444413471458e-64
	NC - Networking and Communications	2.681749056326802e-68
	OS - Operating Systems	6.704372640817005e-69
	PBD - Platform-based Development	-
	PD - Parallel and Distributed Computing	1.340874528163401e-68
	PL - Programming Languages	1.7163193960491532e-66
SDF - Software Development Fundamental	1.6760931602042511e-69	

	SE - Software Engineering	2.1453992450614415e-67
	SF - Systems Fundamentals	5.363498112653604e-68
	SP - Social Issues and Professional Practice	6.704372640817005e-69

Subject	Knowledge Area	Probability
1565020 Mobile Programming	AL - Algorithms and Complexity	4.450113605665785e-36
	AR - Architecture and Organization	8.90022721133157e-36
	CN - Computational Science	3.560090884532628e-35
	DS - Discrete Structures	-
	GV - Graphics and Visualization	3.560090884532628e-35
	HCI - Human-Computer Interaction	2.278458166100882e-33
	IAS - Information Assurance and Security	2.278458166100882e-33
	IM - Information Management	3.560090884532628e-35
	IS - Intelligent Systems	1.780045442266314e-35
	NC - Networking and Communications	7.120181769065256e-35
	OS - Operating Systems	1.4240363538130513e-34
	PBD - Platform-based Development	3.560090884532628e-35
	PD - Parallel and Distributed Computing	3.560090884532628e-35
	PL - Programming Languages	1.139229083050441e-33
	SDF - Software Development Fundamental	3.560090884532628e-35
SE - Software Engineering	1.4240363538130513e-34	
SF - Systems Fundamentals	3.560090884532628e-35	
SP - Social Issues and Professional Practice	1.4240363538130513e-34	

Subject	Knowledge Area	Probability
1565021 Information System	AL - Algorithms and Complexity	4.939101994232865e-47
	AR - Architecture and Organization	1.2347754985582163e-47
	CN - Computational Science	3.161025276309034e-45
	DS - Discrete Structures	1.5434693731977704e-48
	GV - Graphics and Visualization	9.87820398846573e-47
	HCI - Human-Computer Interaction	1.2644101105236135e-44
	IAS - Information Assurance and Security	1.580512638154517e-45
	IM - Information Management	3.951281595386292e-46

	IS - Intelligent Systems	9.87820398846573e-47
	NC - Networking and Communications	3.951281595386292e-46
	OS - Operating Systems	1.975640797693146e-46
	PBD - Platform-based Development	1.5434693731977704e-48
	PD - Parallel and Distributed Computing	2.4695509971164326e-47
	PL - Programming Languages	3.951281595386292e-46
	SDF - Software Development Fundamental	9.87820398846573e-47
	SE - Software Engineering	5.057640442094454e-44
	SF - Systems Fundamentals	9.87820398846573e-47
	SP - Social Issues and Professional Practice	1.580512638154517e-45

Subject	Knowledge Area	Probability
1565022 Multimedia & Game Programming	AL - Algorithms and Complexity	1.8220027779899235e-22
	AR - Architecture and Organization	7.288011111959694e-22
	CN - Computational Science	3.644005555979847e-22
	DS - Discrete Structures	1.8220027779899235e-22
	GV - Graphics and Visualization	3.644005555979847e-22
	HCI - Human-Computer Interaction	3.644005555979847e-22
	IAS - Information Assurance and Security	7.288011111959694e-22
	IM - Information Management	1.4576022223919388e-21
	IS - Intelligent Systems	7.288011111959694e-22
	NC - Networking and Communications	-
	OS - Operating Systems	1.8220027779899235e-22
	PBD - Platform-based Development	-
	PD - Parallel and Distributed Computing	3.644005555979847e-22
	PL - Programming Languages	7.288011111959694e-22
	SDF - Software Development Fundamental	3.644005555979847e-22
	SE - Software Engineering	1.4576022223919388e-21
SF - Systems Fundamentals	3.644005555979847e-22	
SP - Social Issues and Professional Practice	1.8220027779899235e-22	

Subject	Knowledge Area	Probability
1565023	AL - Algorithms and Complexity	7.903749233545443e-46
	AR - Architecture and Organization	6.322999386836354e-45

Distributed System & Security	CN - Computational Science	3.9518746167727215e-46
	DS - Discrete Structures	-
	GV - Graphics and Visualization	1.9759373083863607e-46
	HCI - Human-Computer Interaction	1.0116799018938167e-43
	IAS - Information Assurance and Security	2.589900548848171e-41
	IM - Information Management	6.322999386836354e-45
	IS - Intelligent Systems	1.9759373083863607e-46
	NC - Networking and Communications	1.2645998773672709e-44
	OS - Operating Systems	5.0583995094690835e-44
	PBD - Platform-based Development	1.5807498467090886e-45
	PD - Parallel and Distributed Computing	7.903749233545443e-46
	PL - Programming Languages	3.161499693418177e-45
	SDF - Software Development Fundamental	1.9759373083863607e-46
	SE - Software Engineering	6.322999386836354e-45
	SF - Systems Fundamentals	5.0583995094690835e-44
SP - Social Issues and Professional Practice	1.2645998773672709e-44	

Subject	Knowledge Area	Probability
1565024 Research Methodology	AL - Algorithms and Complexity	2.0054725929002857e-57
	AR - Architecture and Organization	1.2534203705626786e-58
	CN - Computational Science	1.0027362964501429e-57
	DS - Discrete Structures	6.267101852813393e-59
	GV - Graphics and Visualization	2.0054725929002857e-57
	HCI - Human-Computer Interaction	3.208756148640457e-56
	IAS - Information Assurance and Security	4.0109451858005714e-57
	IM - Information Management	5.013681482250714e-58
	IS - Intelligent Systems	4.0109451858005714e-57
	NC - Networking and Communications	5.013681482250714e-58
	OS - Operating Systems	1.0027362964501429e-57
	PBD - Platform-based Development	2.506840741125357e-58
	PD - Parallel and Distributed Computing	5.013681482250714e-58
	PL - Programming Languages	1.2835024594561829e-55
	SDF - Software Development Fundamental	1.0027362964501429e-57
SE - Software Engineering	1.0027362964501429e-57	

	SF - Systems Fundamentals	1.0027362964501429e-57
	SP - Social Issues and Professional Practice	4.0109451858005714e-57

Subject	Knowledge Area	Probability
1565025 Geographical Information System	AL - Algorithms and Complexity	3.299869265013793e-30
	AR - Architecture and Organization	3.299869265013793e-30
	CN - Computational Science	5.279790824022069e-29
	DS - Discrete Structures	1.6499346325068966e-30
	GV - Graphics and Visualization	1.0559581648044138e-28
	HCI - Human-Computer Interaction	6.599738530027586e-30
	IAS - Information Assurance and Security	1.3199477060055173e-29
	IM - Information Management	1.3199477060055173e-29
	IS - Intelligent Systems	2.6398954120110346e-29
	NC - Networking and Communications	1.3199477060055173e-29
	OS - Operating Systems	3.299869265013793e-30
	PBD - Platform-based Development	-
	PD - Parallel and Distributed Computing	2.6398954120110346e-29
	PL - Programming Languages	1.3199477060055173e-29
	SDF - Software Development Fundamental	-
	SE - Software Engineering	3.299869265013793e-30
SF - Systems Fundamentals	2.6398954120110346e-29	
SP - Social Issues and Professional Practice	6.599738530027586e-30	

Subject	Knowledge Area	Probability
1565026 Operation Research	AL - Algorithms and Complexity	5.7666838957456746e-24
	AR - Architecture and Organization	1.8020887174205233e-25
	CN - Computational Science	4.6133471165965397e-23
	DS - Discrete Structures	9.010443587102617e-26
	GV - Graphics and Visualization	1.4416709739364187e-24
	HCI - Human-Computer Interaction	1.4416709739364187e-24
	IAS - Information Assurance and Security	1.4416709739364187e-24
	IM - Information Management	3.6041774348410466e-25
	IS - Intelligent Systems	5.7666838957456746e-24
	NC - Networking and Communications	7.208354869682093e-25

	OS - Operating Systems	9.010443587102617e-26
	PBD - Platform-based Development	1.8020887174205233e-25
	PD - Parallel and Distributed Computing	1.4416709739364187e-24
	PL - Programming Languages	7.208354869682093e-25
	SDF - Software Development Fundamental	1.8020887174205233e-25
	SE - Software Engineering	7.208354869682093e-25
	SF - Systems Fundamentals	3.6041774348410466e-25
	SP - Social Issues and Professional Practice	7.208354869682093e-25

Subject	Knowledge Area	Probability
1565027 Human Computer Interaction	AL - Algorithms and Complexity	5.57968005665324e-19
	AR - Architecture and Organization	5.57968005665324e-19
	CN - Computational Science	4.463744045322592e-18
	DS - Discrete Structures	-
	GV - Graphics and Visualization	1.115936011330648e-18
	HCI - Human-Computer Interaction	7.141990472516147e-17
	IAS - Information Assurance and Security	4.463744045322592e-18
	IM - Information Management	4.463744045322592e-18
	IS - Intelligent Systems	1.115936011330648e-18
	NC - Networking and Communications	1.115936011330648e-18
	OS - Operating Systems	2.231872022661296e-18
	PBD - Platform-based Development	-
	PD - Parallel and Distributed Computing	5.57968005665324e-19
	PL - Programming Languages	1.115936011330648e-18
	SDF - Software Development Fundamental	2.231872022661296e-18
	SE - Software Engineering	8.927488090645183e-18
SF - Systems Fundamentals	1.115936011330648e-18	
SP - Social Issues and Professional Practice	8.927488090645183e-18	

Subject	Knowledge Area	Probability
1565028 Operating System	AL - Algorithms and Complexity	2.7046198073415797e-42
	AR - Architecture and Organization	3.461913353397222e-40
	CN - Computational Science	3.461913353397222e-40
	DS - Discrete Structures	-

	GV - Graphics and Visualization	1.0818479229366319e-41
	HCI - Human-Computer Interaction	1.3847653413588888e-39
	IAS - Information Assurance and Security	8.862498184696888e-38
	IM - Information Management	2.7695306827177776e-39
	IS - Intelligent Systems	1.0818479229366319e-41
	NC - Networking and Communications	3.461913353397222e-40
	OS - Operating Systems	4.431249092348444e-38
	PBD - Platform-based Development	2.1636958458732637e-41
	PD - Parallel and Distributed Computing	2.7695306827177776e-39
	PL - Programming Languages	5.539061365435555e-39
	SDF - Software Development Fundamental	1.0818479229366319e-41
	SE - Software Engineering	3.461913353397222e-40
	SF - Systems Fundamentals	5.539061365435555e-39
	SP - Social Issues and Professional Practice	1.107812273087111e-38

Subject	Knowledge Area	Probability
1565029 Technopreneurship	AL - Algorithms and Complexity	5.129555009111083e-25
	AR - Architecture and Organization	5.129555009111083e-25
	CN - Computational Science	4.103644007288866e-24
	DS - Discrete Structures	5.129555009111083e-25
	GV - Graphics and Visualization	1.0259110018222166e-24
	HCI - Human-Computer Interaction	2.051822003644433e-24
	IAS - Information Assurance and Security	5.129555009111083e-25
	IM - Information Management	-
	IS - Intelligent Systems	1.0259110018222166e-24
	NC - Networking and Communications	5.129555009111083e-25
	OS - Operating Systems	1.0259110018222166e-24
	PBD - Platform-based Development	
	PD - Parallel and Distributed Computing	4.103644007288866e-24
	PL - Programming Languages	2.051822003644433e-24
	SDF - Software Development Fundamental	-
	SE - Software Engineering	3.282915205831093e-23
SF - Systems Fundamentals	1.0259110018222166e-24	

	SP - Social Issues and Professional Practice	5.129555009111083e-25
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Subject	Knowledge Area	Probability
1565030 Project Management	AL - Algorithms and Complexity	1.0742895452406476e-45
	AR - Architecture and Organization	6.714309657754047e-47
	CN - Computational Science	8.59431636192518e-45
	DS - Discrete Structures	6.714309657754047e-47
	GV - Graphics and Visualization	2.685723863101619e-46
	HCI - Human-Computer Interaction	3.437726544770072e-44
	IAS - Information Assurance and Security	1.718863272385036e-44
	IM - Information Management	4.29715818096259e-45
	IS - Intelligent Systems	2.148579090481295e-45
	NC - Networking and Communications	1.718863272385036e-44
	OS - Operating Systems	1.718863272385036e-44
	PBD - Platform-based Development	6.714309657754047e-47
	PD - Parallel and Distributed Computing	8.59431636192518e-45
	PL - Programming Languages	6.875453089540144e-44
	SDF - Software Development Fundamental	2.685723863101619e-46
	SE - Software Engineering	2.2001449886528462e-42
SF - Systems Fundamentals	4.29715818096259e-45	
SP - Social Issues and Professional Practice	2.7501812358160578e-43	

Subject	Knowledge Area	Probability
1565031 Algorithm & Programming 1 Practicum	AL - Algorithms and Complexity	6.6930104377457e-45
	AR - Architecture and Organization	2.67720417509828e-44
	CN - Computational Science	1.070881670039312e-43
	DS - Discrete Structures	6.6930104377457e-45
	GV - Graphics and Visualization	5.35440835019656e-44
	HCI - Human-Computer Interaction	8.567053360314496e-43
	IAS - Information Assurance and Security	2.141763340078624e-43
	IM - Information Management	2.141763340078624e-43
	IS - Intelligent Systems	1.070881670039312e-43
	NC - Networking and Communications	1.070881670039312e-43
	OS - Operating Systems	2.67720417509828e-44

	PBD - Platform-based Development	1.33860208754914e-44
	PD - Parallel and Distributed Computing	5.35440835019656e-44
	PL - Programming Languages	1.7134106720628993e-42
	SDF - Software Development Fundamental	4.283526680157248e-43
	SE - Software Engineering	3.4268213441257985e-42
	SF - Systems Fundamentals	1.33860208754914e-44
	SP - Social Issues and Professional Practice	1.33860208754914e-44

Subject	Knowledge Area	Probability
1565032 Data Structure Practicum	AL - Algorithms and Complexity	4.060510717946288e-21
	AR - Architecture and Organization	1.5861369991977687e-23
	CN - Computational Science	1.5861369991977687e-23
	DS - Discrete Structures	3.1722739983955374e-23
	GV - Graphics and Visualization	7.930684995988843e-24
	HCI - Human-Computer Interaction	
	IAS - Information Assurance and Security	7.930684995988843e-24
	IM - Information Management	7.930684995988843e-24
	IS - Intelligent Systems	1.5861369991977687e-23
	NC - Networking and Communications	7.930684995988843e-24
	OS - Operating Systems	7.930684995988843e-24
	PBD - Platform-based Development	7.930684995988843e-24
	PD - Parallel and Distributed Computing	7.930684995988843e-24
	PL - Programming Languages	6.344547996791075e-23
	SDF - Software Development Fundamental	2.53781919871643e-22
SE - Software Engineering		
SF - Systems Fundamentals	7.930684995988843e-24	
SP - Social Issues and Professional Practice		

Subject	Knowledge Area	Probability
1565033 Digital Electronic Practicum	AL - Algorithms and Complexity	
	AR - Architecture and Organization	9.556363693110547e-33
	CN - Computational Science	1.1945454616388183e-33
	DS - Discrete Structures	4.778181846555273e-33
	GV - Graphics and Visualization	1.1945454616388183e-33

	HCI - Human-Computer Interaction	
	IAS - Information Assurance and Security	2.3890909232776366e-33
	IM - Information Management	2.3890909232776366e-33
	IS - Intelligent Systems	2.3890909232776366e-33
	NC - Networking and Communications	
	OS - Operating Systems	
	PBD - Platform-based Development	
	PD - Parallel and Distributed Computing	2.3890909232776366e-33
	PL - Programming Languages	4.778181846555273e-33
	SDF - Software Development Fundamental	2.3890909232776366e-33
	SE - Software Engineering	1.1945454616388183e-33
	SF - Systems Fundamentals	9.556363693110547e-33
	SP - Social Issues and Professional Practice	1.1945454616388183e-33

Subject	Knowledge Area	Probability
1565034 Object Oriented Programming Practicum	AL - Algorithms and Complexity	6.676929387618025e-30
	AR - Architecture and Organization	1.6692323469045063e-30
	CN - Computational Science	3.3384646938090126e-30
	DS - Discrete Structures	1.6692323469045063e-30
	GV - Graphics and Visualization	1.6692323469045063e-30
	HCI - Human-Computer Interaction	6.676929387618025e-30
	IAS - Information Assurance and Security	1.335385877523605e-29
	IM - Information Management	1.335385877523605e-29
	IS - Intelligent Systems	6.676929387618025e-30
	NC - Networking and Communications	2.67077175504721e-29
	OS - Operating Systems	1.6692323469045063e-30
	PBD - Platform-based Development	1.6692323469045063e-30
	PD - Parallel and Distributed Computing	1.6692323469045063e-30
	PL - Programming Languages	1.7092939232302144e-27
	SDF - Software Development Fundamental	5.34154351009442e-29
SE - Software Engineering	5.34154351009442e-29	
SF - Systems Fundamentals	3.3384646938090126e-30	

	SP - Social Issues and Professional Practice	3.3384646938090126e-30
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Subject	Knowledge Area	Probability
1565035 Mobile Programming Practicum	AL - Algorithms and Complexity	3.958938011018148e-22
	AR - Architecture and Organization	1.979469005509074e-22
	CN - Computational Science	1.979469005509074e-22
	DS - Discrete Structures	
	GV - Graphics and Visualization	3.958938011018148e-22
	HCI - Human-Computer Interaction	1.2668601635258073e-20
	IAS - Information Assurance and Security	1.979469005509074e-22
	IM - Information Management	7.917876022036296e-22
	IS - Intelligent Systems	
	NC - Networking and Communications	1.979469005509074e-22
	OS - Operating Systems	1.979469005509074e-22
	PBD - Platform-based Development	3.958938011018148e-22
	PD - Parallel and Distributed Computing	3.958938011018148e-22
	PL - Programming Languages	1.5835752044072591e-21
	SDF - Software Development Fundamental	1.979469005509074e-22
	SE - Software Engineering	3.958938011018148e-22
SF - Systems Fundamentals	1.979469005509074e-22	
SP - Social Issues and Professional Practice	1.979469005509074e-22	

Subject	Knowledge Area	Probability
1565036 Database Practicum	AL - Algorithms and Complexity	7.678101404875666e-35
	AR - Architecture and Organization	3.839050702437833e-35
	CN - Computational Science	3.0712405619502665e-34
	DS - Discrete Structures	7.678101404875666e-35
	GV - Graphics and Visualization	3.839050702437833e-35
	HCI - Human-Computer Interaction	7.678101404875666e-35
	IAS - Information Assurance and Security	3.0712405619502665e-34
	IM - Information Management	1.2284962247801066e-33
	IS - Intelligent Systems	7.678101404875666e-35
	NC - Networking and Communications	3.839050702437833e-35
	OS - Operating Systems	1.9195253512189166e-35

	PBD - Platform-based Development	1.9195253512189166e-35
	PD - Parallel and Distributed Computing	3.839050702437833e-35
	PL - Programming Languages	6.142481123900533e-34
	SDF - Software Development Fundamental	3.839050702437833e-35
	SE - Software Engineering	3.0712405619502665e-34
	SF - Systems Fundamentals	1.9195253512189166e-35
	SP - Social Issues and Professional Practice	3.839050702437833e-35

Subject	Knowledge Area	Probability
1565037 Computer System Practicum	AL - Algorithms and Complexity	2.0021235282111896e-40
	AR - Architecture and Organization	6.406795290275807e-39
	CN - Computational Science	8.008494112844759e-40
	DS - Discrete Structures	
	GV - Graphics and Visualization	2.0021235282111896e-40
	HCI - Human-Computer Interaction	3.2033976451379034e-39
	IAS - Information Assurance and Security	2.5627181161103227e-38
	IM - Information Management	8.008494112844759e-40
	IS - Intelligent Systems	2.0021235282111896e-40
	NC - Networking and Communications	4.004247056422379e-40
	OS - Operating Systems	1.6016988225689517e-39
	PBD - Platform-based Development	
	PD - Parallel and Distributed Computing	3.2033976451379034e-39
	PL - Programming Languages	1.6016988225689517e-39
	SDF - Software Development Fundamental	4.004247056422379e-40
	SE - Software Engineering	1.6016988225689517e-39
SF - Systems Fundamentals	4.004247056422379e-40	
SP - Social Issues and Professional Practice	4.004247056422379e-40	

Subject	Knowledge Area	Probability
1565038 Web Programming Practicum	AL - Algorithms and Complexity	
	AR - Architecture and Organization	
	CN - Computational Science	1.7868513700615857e-41
	DS - Discrete Structures	
	GV - Graphics and Visualization	1.7868513700615857e-41

	HCI - Human-Computer Interaction	7.147405480246343e-41
	IAS - Information Assurance and Security	1.4294810960492686e-40
	IM - Information Management	1.4294810960492686e-40
	IS - Intelligent Systems	3.5737027401231715e-41
	NC - Networking and Communications	7.147405480246343e-41
	OS - Operating Systems	7.147405480246343e-41
	PBD - Platform-based Development	2.858962192098537e-40
	PD - Parallel and Distributed Computing	1.4294810960492686e-40
	PL - Programming Languages	1.4294810960492686e-40
	SDF - Software Development Fundamental	1.7868513700615857e-41
	SE - Software Engineering	7.147405480246343e-41
	SF - Systems Fundamentals	
	SP - Social Issues and Professional Practice	7.147405480246343e-41

Subject	Knowledge Area	Probability
1565039 Software Engineering Practicum	AL - Algorithms and Complexity	2.7145837195329795e-24
	AR - Architecture and Organization	
	CN - Computational Science	4.343333951252767e-23
	DS - Discrete Structures	2.7145837195329795e-24
	GV - Graphics and Visualization	1.3572918597664898e-24
	HCI - Human-Computer Interaction	4.343333951252767e-23
	IAS - Information Assurance and Security	8.686667902505535e-23
	IM - Information Management	4.343333951252767e-23
	IS - Intelligent Systems	2.1716669756263836e-23
	NC - Networking and Communications	1.0858334878131918e-23
	OS - Operating Systems	1.0858334878131918e-23
	PBD - Platform-based Development	5.429167439065959e-24
	PD - Parallel and Distributed Computing	2.1716669756263836e-23
	PL - Programming Languages	2.1716669756263836e-23
	SDF - Software Development Fundamental	2.7145837195329795e-24
	SE - Software Engineering	6.949334322004428e-22
SF - Systems Fundamentals	5.429167439065959e-24	
SP - Social Issues and Professional Practice	8.686667902505535e-23	

Subject	Knowledge Area	Probability
1565040 Information System Practicum	AL - Algorithms and Complexity	8.132201867904116e-27
	AR - Architecture and Organization	3.2528807471616464e-26
	CN - Computational Science	1.3011522988646586e-25
	DS - Discrete Structures	
	GV - Graphics and Visualization	1.6264403735808232e-26
	HCI - Human-Computer Interaction	1.3011522988646586e-25
	IAS - Information Assurance and Security	5.204609195458634e-25
	IM - Information Management	1.3011522988646586e-25
	IS - Intelligent Systems	3.2528807471616464e-26
	NC - Networking and Communications	6.505761494323293e-26
	OS - Operating Systems	6.505761494323293e-26
	PBD - Platform-based Development	1.6264403735808232e-26
	PD - Parallel and Distributed Computing	3.2528807471616464e-26
	PL - Programming Languages	3.2528807471616464e-26
	SDF - Software Development Fundamental	3.2528807471616464e-26
SE - Software Engineering	2.602304597729317e-25	
SF - Systems Fundamentals	6.505761494323293e-26	
SP - Social Issues and Professional Practice	3.2528807471616464e-26	

Subject	Knowledge Area	Probability
1565041 Computer Graphic Practicum	AL - Algorithms and Complexity	3.1239619941488662e-21
	AR - Architecture and Organization	3.1239619941488662e-21
	CN - Computational Science	1.2495847976595465e-20
	DS - Discrete Structures	
	GV - Graphics and Visualization	9.996678381276372e-20
	HCI - Human-Computer Interaction	2.499169595319093e-20
	IAS - Information Assurance and Security	3.1239619941488662e-21
	IM - Information Management	2.499169595319093e-20
	IS - Intelligent Systems	1.2495847976595465e-20
	NC - Networking and Communications	1.2495847976595465e-20
	OS - Operating Systems	3.1239619941488662e-21
	PBD - Platform-based Development	
PD - Parallel and Distributed Computing		

	PL - Programming Languages	1.2495847976595465e-20
	SDF - Software Development Fundamental	
	SE - Software Engineering	2.499169595319093e-20
	SF - Systems Fundamentals	
	SP - Social Issues and Professional Practice	

Subject	Knowledge Area	Probability
1565042 Computer Network Practicum	AL - Algorithms and Complexity	6.803597888923545e-36
	AR - Architecture and Organization	6.803597888923545e-36
	CN - Computational Science	1.7008994722308863e-36
	DS - Discrete Structures	8.504497361154432e-37
	GV - Graphics and Visualization	1.7008994722308863e-36
	HCI - Human-Computer Interaction	8.504497361154432e-37
	IAS - Information Assurance and Security	2.721439155569418e-35
	IM - Information Management	1.360719577784709e-35
	IS - Intelligent Systems	1.360719577784709e-35
	NC - Networking and Communications	5.442878311138836e-35
	OS - Operating Systems	1.7008994722308863e-36
	PBD - Platform-based Development	1.7008994722308863e-36
	PD - Parallel and Distributed Computing	3.4017989444617726e-36
	PL - Programming Languages	6.803597888923545e-36
	SDF - Software Development Fundamental	8.504497361154432e-37
	SE - Software Engineering	2.721439155569418e-35
SF - Systems Fundamentals	3.4017989444617726e-36	
SP - Social Issues and Professional Practice	1.7008994722308863e-36	

Subject	Knowledge Area	Probability
1565043 Multimedia & Game Programming Practicum	AL - Algorithms and Complexity	1.104475865657025e-28
	AR - Architecture and Organization	
	CN - Computational Science	4.4179034626281e-28
	DS - Discrete Structures	1.104475865657025e-28
	GV - Graphics and Visualization	4.4179034626281e-28
	HCI - Human-Computer Interaction	8.8358069252562e-28
	IAS - Information Assurance and Security	2.20895173131405e-28

	IM - Information Management	2.20895173131405e-28
	IS - Intelligent Systems	4.4179034626281e-28
	NC - Networking and Communications	1.104475865657025e-28
	OS - Operating Systems	
	PBD - Platform-based Development	
	PD - Parallel and Distributed Computing	1.104475865657025e-28
	PL - Programming Languages	4.4179034626281e-28
	SDF - Software Development Fundamental	
	SE - Software Engineering	2.20895173131405e-28
	SF - Systems Fundamentals	2.20895173131405e-28
	SP - Social Issues and Professional Practice	2.20895173131405e-28

Subject	Knowledge Area	Probability
1565044 Distributed System Practicum	AL - Algorithms and Complexity	6.860903319518554e-32
	AR - Architecture and Organization	5.488722655614843e-31
	CN - Computational Science	5.488722655614843e-31
	DS - Discrete Structures	
	GV - Graphics and Visualization	2.7443613278074216e-31
	HCI - Human-Computer Interaction	1.0977445311229686e-30
	IAS - Information Assurance and Security	2.1954890622459373e-30
	IM - Information Management	1.0977445311229686e-30
	IS - Intelligent Systems	1.0977445311229686e-30
	NC - Networking and Communications	8.781956248983749e-30
	OS - Operating Systems	2.7443613278074216e-31
	PBD - Platform-based Development	1.3721806639037108e-31
	PD - Parallel and Distributed Computing	2.7443613278074216e-31
	PL - Programming Languages	1.0977445311229686e-30
	SDF - Software Development Fundamental	1.3721806639037108e-31
	SE - Software Engineering	2.7443613278074216e-31
	SF - Systems Fundamentals	2.7443613278074216e-31
SP - Social Issues and Professional Practice	5.488722655614843e-31	

Subject	Knowledge Area	Probability
1565045 Geographical Information System Practicum	AL - Algorithms and Complexity	4.518353164748973e-22
	AR - Architecture and Organization	1.1295882911872432e-22
	CN - Computational Science	4.518353164748973e-22
	DS - Discrete Structures	2.2591765823744863e-22
	GV - Graphics and Visualization	4.518353164748973e-22
	HCI - Human-Computer Interaction	4.518353164748973e-22
	IAS - Information Assurance and Security	4.518353164748973e-22
	IM - Information Management	9.036706329497945e-22
	IS - Intelligent Systems	4.518353164748973e-22
	NC - Networking and Communications	4.518353164748973e-22
	OS - Operating Systems	
	PBD - Platform-based Development	1.1295882911872432e-22
	PD - Parallel and Distributed Computing	4.518353164748973e-22
	PL - Programming Languages	9.036706329497945e-22
	SDF - Software Development Fundamental	2.2591765823744863e-22
SE - Software Engineering	4.518353164748973e-22	
SF - Systems Fundamentals	2.2591765823744863e-22	
SP - Social Issues and Professional Practice	2.2591765823744863e-22	

Subject	Knowledge Area	Probability
1565049 Soft Computing (Opt Subj 1)*	AL - Algorithms and Complexity	1.831072274615301e-19
	AR - Architecture and Organization	9.155361373076505e-20
	CN - Computational Science	1.831072274615301e-19
	DS - Discrete Structures	9.155361373076505e-20
	GV - Graphics and Visualization	1.831072274615301e-19
	HCI - Human-Computer Interaction	9.155361373076505e-20
	IAS - Information Assurance and Security	9.155361373076505e-20
	IM - Information Management	4.5776806865382526e-20
	IS - Intelligent Systems	3.662144549230602e-19
	NC - Networking and Communications	4.5776806865382526e-20
	OS - Operating Systems	4.5776806865382526e-20
	PBD - Platform-based Development	
	PD - Parallel and Distributed Computing	3.662144549230602e-19
PL - Programming Languages	9.155361373076505e-20	

	SDF - Software Development Fundamental	9.155361373076505e-20
	SE - Software Engineering	4.5776806865382526e-20
	SF - Systems Fundamentals	1.831072274615301e-19
	SP - Social Issues and Professional Practice	1.831072274615301e-19

Subject	Knowledge Area	Probability
1565050 Visualization & Modeling (Opt Subj 2)*	AL - Algorithms and Complexity	3.6173717977679175e-12
	AR - Architecture and Organization	
	CN - Computational Science	7.234743595535835e-12
	DS - Discrete Structures	
	GV - Graphics and Visualization	5.787794876428668e-11
	HCI - Human-Computer Interaction	
	IAS - Information Assurance and Security	
	IM - Information Management	1.446948719107167e-11
	IS - Intelligent Systems	7.234743595535835e-12
	NC - Networking and Communications	1.446948719107167e-11
	OS - Operating Systems	3.6173717977679175e-12
	PBD - Platform-based Development	
	PD - Parallel and Distributed Computing	3.6173717977679175e-12
	PL - Programming Languages	3.6173717977679175e-12
	SDF - Software Development Fundamental	
SE - Software Engineering	3.6173717977679175e-12	
SF - Systems Fundamentals	3.6173717977679175e-12	
SP - Social Issues and Professional Practice		

Subject	Knowledge Area	Probability
1565051 Software Quality (Opt Subj 1)*	AL - Algorithms and Complexity	3.919514027420192e-11
	AR - Architecture and Organization	
	CN - Computational Science	7.839028054840383e-11
	DS - Discrete Structures	3.919514027420192e-11
	GV - Graphics and Visualization	3.919514027420192e-11
	HCI - Human-Computer Interaction	7.839028054840383e-11
	IAS - Information Assurance and Security	3.1356112219361534e-10
	IM - Information Management	7.839028054840383e-11

	IS - Intelligent Systems	1.5678056109680767e-10
	NC - Networking and Communications	7.839028054840383e-11
	OS - Operating Systems	7.839028054840383e-11
	PBD - Platform-based Development	3.919514027420192e-11
	PD - Parallel and Distributed Computing	7.839028054840383e-11
	PL - Programming Languages	7.839028054840383e-11
	SDF - Software Development Fundamental	
	SE - Software Engineering	6.271222443872307e-10
	SF - Systems Fundamentals	3.919514027420192e-11
	SP - Social Issues and Professional Practice	1.5678056109680767e-10

Subject	Knowledge Area	Probability
1565052 Software Management (Opt Subj 2)*	AL - Algorithms and Complexity	7.060591513754089e-13
	AR - Architecture and Organization	7.060591513754089e-13
	CN - Computational Science	5.6484732110032715e-12
	DS - Discrete Structures	
	GV - Graphics and Visualization	1.4121183027508179e-12
	HCI - Human-Computer Interaction	1.1296946422006543e-11
	IAS - Information Assurance and Security	5.6484732110032715e-12
	IM - Information Management	5.6484732110032715e-12
	IS - Intelligent Systems	7.060591513754089e-13
	NC - Networking and Communications	1.4121183027508179e-12
	OS - Operating Systems	2.2593892844013086e-11
	PBD - Platform-based Development	1.4121183027508179e-12
	PD - Parallel and Distributed Computing	5.6484732110032715e-12
	PL - Programming Languages	2.2593892844013086e-11
	SDF - Software Development Fundamental	7.060591513754089e-13
	SE - Software Engineering	1.1296946422006543e-11
SF - Systems Fundamentals	5.6484732110032715e-12	
SP - Social Issues and Professional Practice	4.518778568802617e-11	

Subject	Knowledge Area	Probability
1565053	AL - Algorithms and Complexity	
	AR - Architecture and Organization	7.186491438732914e-15

Enterprise Architecture (Opt Subj 1)*	CN - Computational Science	2.8745965754931655e-14
	DS - Discrete Structures	
	GV - Graphics and Visualization	1.4372982877465828e-14
	HCI - Human-Computer Interaction	5.749193150986331e-14
	IAS - Information Assurance and Security	5.749193150986331e-14
	IM - Information Management	2.8745965754931655e-14
	IS - Intelligent Systems	
	NC - Networking and Communications	1.4372982877465828e-14
	OS - Operating Systems	1.4372982877465828e-14
	PBD - Platform-based Development	7.186491438732914e-15
	PD - Parallel and Distributed Computing	1.4372982877465828e-14
	PL - Programming Languages	7.186491438732914e-15
	SDF - Software Development Fundamental	
	SE - Software Engineering	1.4372982877465828e-14
	SF - Systems Fundamentals	2.8745965754931655e-14
SP - Social Issues and Professional Practice	1.4372982877465828e-14	

Subject	Knowledge Area	Probability
1565054 IT Governance (Opt Subj 2)*	AL - Algorithms and Complexity	
	AR - Architecture and Organization	
	CN - Computational Science	
	DS - Discrete Structures	
	GV - Graphics and Visualization	
	HCI - Human-Computer Interaction	
	IAS - Information Assurance and Security	
	IM - Information Management	
	IS - Intelligent Systems	
	NC - Networking and Communications	
	OS - Operating Systems	
	PBD - Platform-based Development	
	PD - Parallel and Distributed Computing	
	PL - Programming Languages	
	SDF - Software Development Fundamental	
SE - Software Engineering		

	SF - Systems Fundamentals	
	SP - Social Issues and Professional Practice	

Subject	Knowledge Area	Probability
1565055 Scenario Design (Opt Subj 1)*	AL - Algorithms and Complexity	9.468983610904391e-15
	AR - Architecture and Organization	9.468983610904391e-15
	CN - Computational Science	1.8937967221808782e-14
	DS - Discrete Structures	
	GV - Graphics and Visualization	1.8937967221808782e-14
	HCI - Human-Computer Interaction	9.468983610904391e-15
	IAS - Information Assurance and Security	1.8937967221808782e-14
	IM - Information Management	1.8937967221808782e-14
	IS - Intelligent Systems	9.468983610904391e-15
	NC - Networking and Communications	1.8937967221808782e-14
	OS - Operating Systems	9.468983610904391e-15
	PBD - Platform-based Development	
	PD - Parallel and Distributed Computing	4.7344918054521954e-15
	PL - Programming Languages	7.575186888723513e-14
	SDF - Software Development Fundamental	9.468983610904391e-15
	SE - Software Engineering	7.575186888723513e-14
SF - Systems Fundamentals	9.468983610904391e-15	
SP - Social Issues and Professional Practice	9.468983610904391e-15	

Subject	Knowledge Area	Probability
1565056 Creative Game & Animation (Opt Subj 2)*	AL - Algorithms and Complexity	7.670188244926008e-19
	AR - Architecture and Organization	3.835094122463004e-19
	CN - Computational Science	6.1361505959408065e-18
	DS - Discrete Structures	
	GV - Graphics and Visualization	3.0680752979704032e-18
	HCI - Human-Computer Interaction	1.2272301191881613e-17
	IAS - Information Assurance and Security	6.1361505959408065e-18
	IM - Information Management	1.5340376489852016e-18
	IS - Intelligent Systems	7.670188244926008e-19
	NC - Networking and Communications	7.670188244926008e-19

	OS - Operating Systems	6.1361505959408065e-18
	PBD - Platform-based Development	3.835094122463004e-19
	PD - Parallel and Distributed Computing	1.5340376489852016e-18
	PL - Programming Languages	6.1361505959408065e-18
	SDF - Software Development Fundamental	3.835094122463004e-19
	SE - Software Engineering	1.2272301191881613e-17
	SF - Systems Fundamentals	3.0680752979704032e-18
	SP - Social Issues and Professional Practice	1.5340376489852016e-18

Subject	Knowledge Area	Probability
1565057 Isu Sosial & Praktek Profesional (Opt Subj 1)*	AL - Algorithms and Complexity	5.1667793164102e-16
	AR - Architecture and Organization	1.03335586328204e-15
	CN - Computational Science	5.1667793164102e-16
	DS - Discrete Structures	
	GV - Graphics and Visualization	5.1667793164102e-16
	HCI - Human-Computer Interaction	5.1667793164102e-16
	IAS - Information Assurance and Security	1.03335586328204e-15
	IM - Information Management	5.1667793164102e-16
	IS - Intelligent Systems	5.1667793164102e-16
	NC - Networking and Communications	1.03335586328204e-15
	OS - Operating Systems	
	PBD - Platform-based Development	
	PD - Parallel and Distributed Computing	1.03335586328204e-15
	PL - Programming Languages	5.1667793164102e-16
	SDF - Software Development Fundamental	5.1667793164102e-16
	SE - Software Engineering	5.1667793164102e-16
	SF - Systems Fundamentals	5.1667793164102e-16
SP - Social Issues and Professional Practice	1.653369381251264e-14	

Subject	Knowledge Area	Probability
1565059 Keamanan Jaringan (Opt Subj 2)*	AL - Algorithms and Complexity	1.1903648538045145e-126
	AR - Architecture and Organization	3.8091675321744465e-125

CN - Computational Science	3.8091675321744465e-125
DS - Discrete Structures	2.9759121345112864e-127
GV - Graphics and Visualization	7.618335064348893e-125
HCI - Human-Computer Interaction	4.8757344411832916e-123
IAS - Information Assurance and Security	5.112578117398211e-117
IM - Information Management	7.618335064348893e-125
IS - Intelligent Systems	4.761459415218058e-126
NC - Networking and Communications	1.5602350211786533e-121
OS - Operating Systems	1.2189336102958229e-123
PBD - Platform-based Development	5.951824269022573e-127
PD - Parallel and Distributed Computing	7.618335064348893e-125
PL - Programming Languages	1.9045837660872233e-125
SDF - Software Development Fundamental	
SE - Software Engineering	3.0473340257395572e-124
SF - Systems Fundamentals	3.0473340257395572e-124
SP - Social Issues and Professional Practice	2.4378672205916458e-123