



Tinjauan Computing Curricula 2020 (CC2020) dan IS2020 (*Competency-Based Computing Learning Model*) Untuk Prodi INFOKOM

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SEKJEN-APTIKOM

2021

Timeline of Curricular Guidelines



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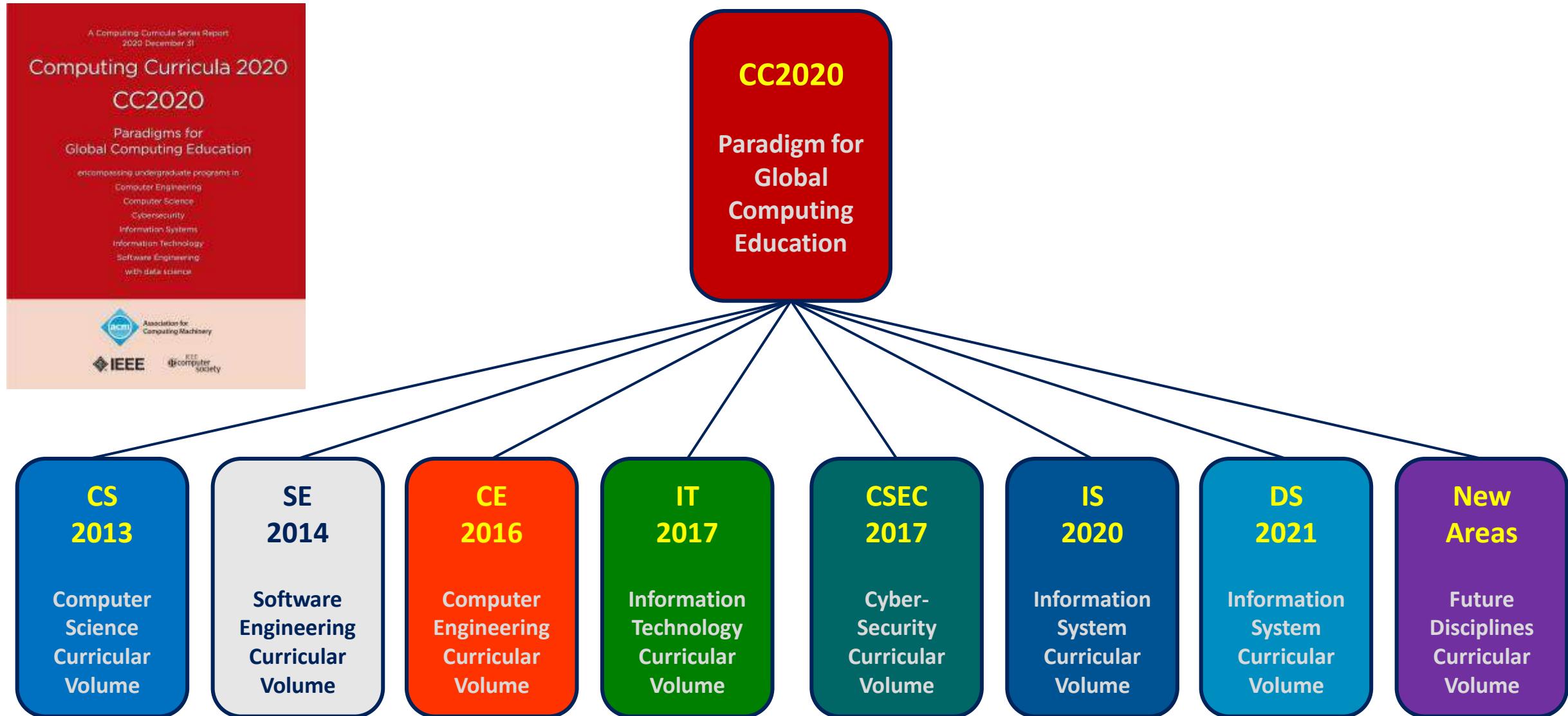
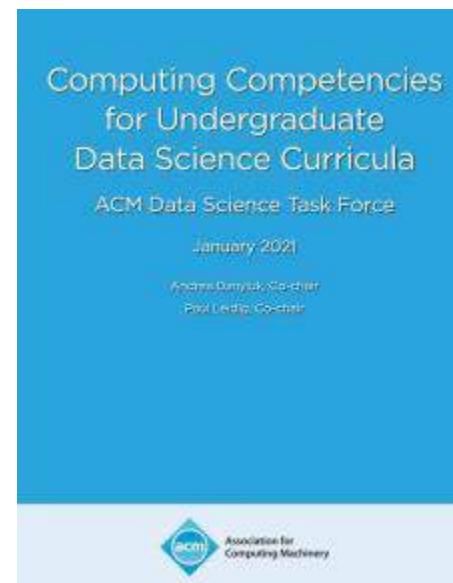
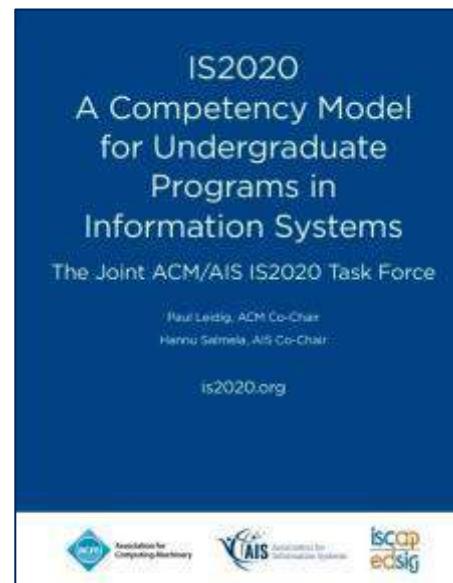
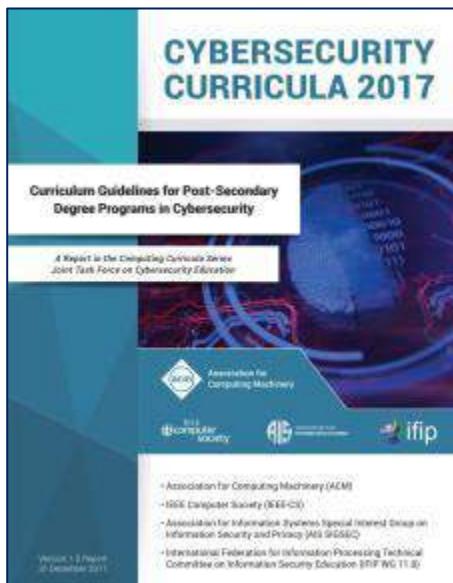
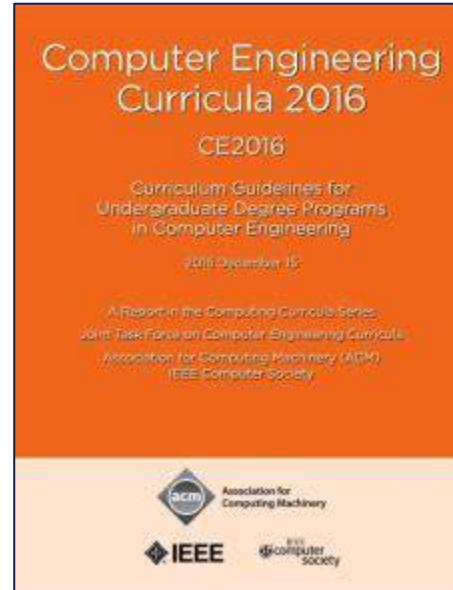
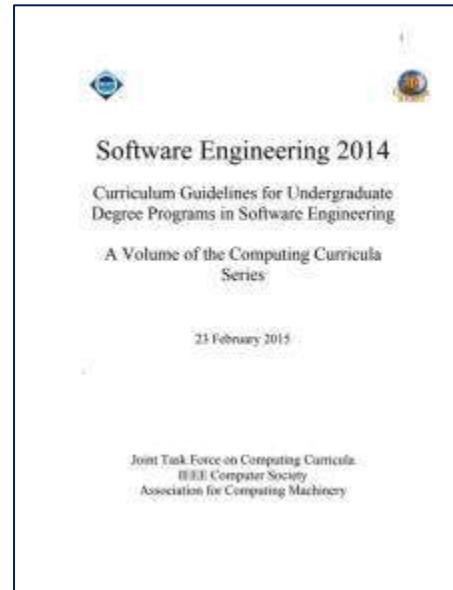
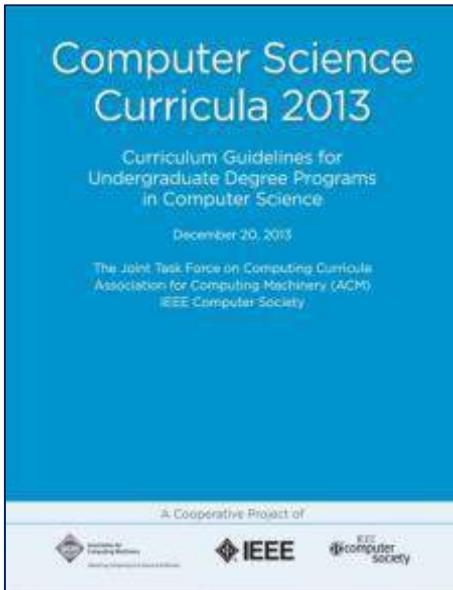
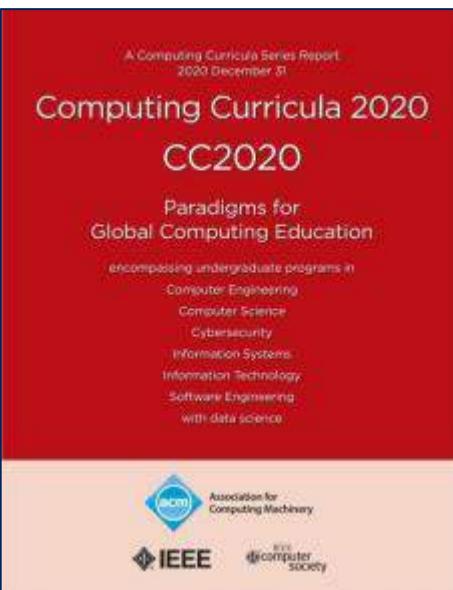


Figure 2.1 Structure of the Computing Curricula Series

Timeline of Curricular Guidelines



Review CC-2005



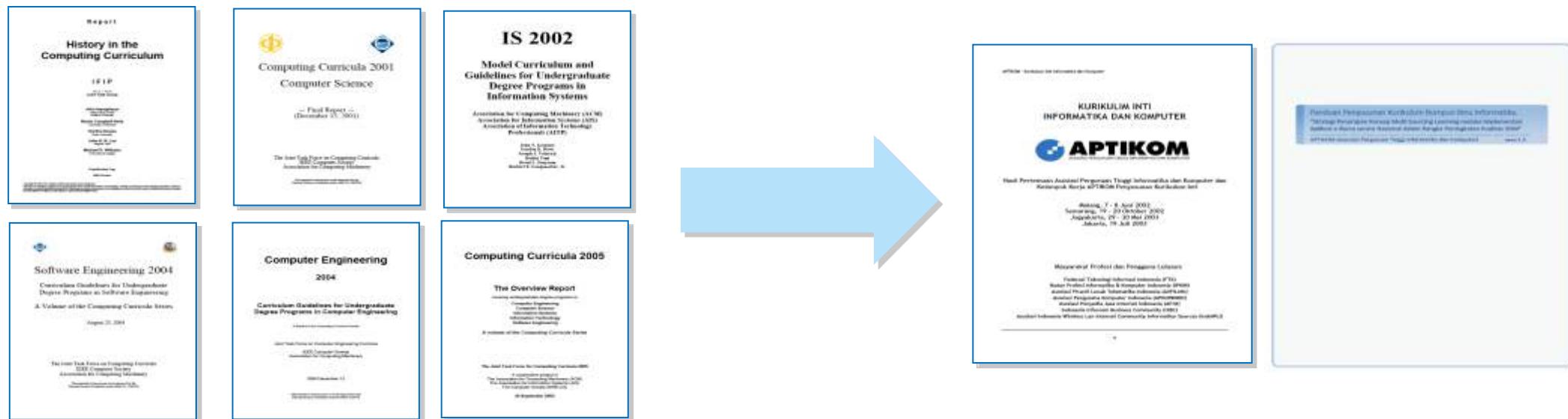
Filosofi dan Struktur Kurikulum Rumpun Ilmu Informatika dan Komputer

Semenjak diperkenalkan di Indonesia, kurikulum rumpun ilmu informatika dan komputer telah mengacu pada sistem dan model kurikulum internasional.

- 1967 COSINE report (Commission on Engineering Education)
- 1968 Curriculum '68 (ACM)
- 1977 A Curriculum in CS and Engineering (IEEE-CS)
- 1978 Curriculum '78 (ACM)
- 1983 Model Program in CS and Engineering (IEEE-CS)
- 1989 Computing as a Discipline
- 1991 Computing Curricula '91 (IEEE-CS + ACM)
- 2001 Computing Curricula 2001 (IEEE-CS + ACM)
- 2005 Computing Curricula 2005 (IEEE-CS + ACM + AIS)
- 2020 Computing Curricula 2020 New

Dalam perjalannya, perkembangan dinamis referensi tersebut mewarnai diperkenalkannya 4 (empat) panduan kurikulum berskala nasional.

- <1995 Kurikulum Lokal (model Amerika Utara dan Eropa)
- 1995-2002 Kurikulum Nasional 1995
- 2003-2007 Kurikulum Inti Berbasis Kompetensi tahun 2003
- 2008-sekarang Kurikulum Berbasis Satuan Pendidikan & Multi-Source Learning



Sejumlah prinsip dasar pengembangan kurikulum dipegang teguh oleh APTIKOM untuk dapat dipertanggungjawabkan secara keilmuan.

- Computing is a broad field that extends **well beyond the boundaries** of computer science.
- Computer science draws its foundations from a **wide variety of disciplines**.
- The **rapid evolution of computer science** requires an ongoing review of the corresponding curriculum.
- Development of a computer science curriculum must be sensitive to **changes in technology, new developments in pedagogy**, and the importance **of lifelong learning**.
- Computing curricula must go **beyond knowledge units** to offer significant guidance in terms of individual course design.
- Computing curricula should seek to identify the **fundamental skills and knowledge** that all computing students must possess.
- The required **body of knowledge** must be made as small as possible.
- Computing curricula must strive to be **international in scope**.
- The development of computing curricula must be **broadly based**.
- Computing curricula must include **professional practice** as an integral component of the undergraduate curriculum.
- Computing curricula must include discussions of **strategies and tactics** for implementation along with high-level recommendations.

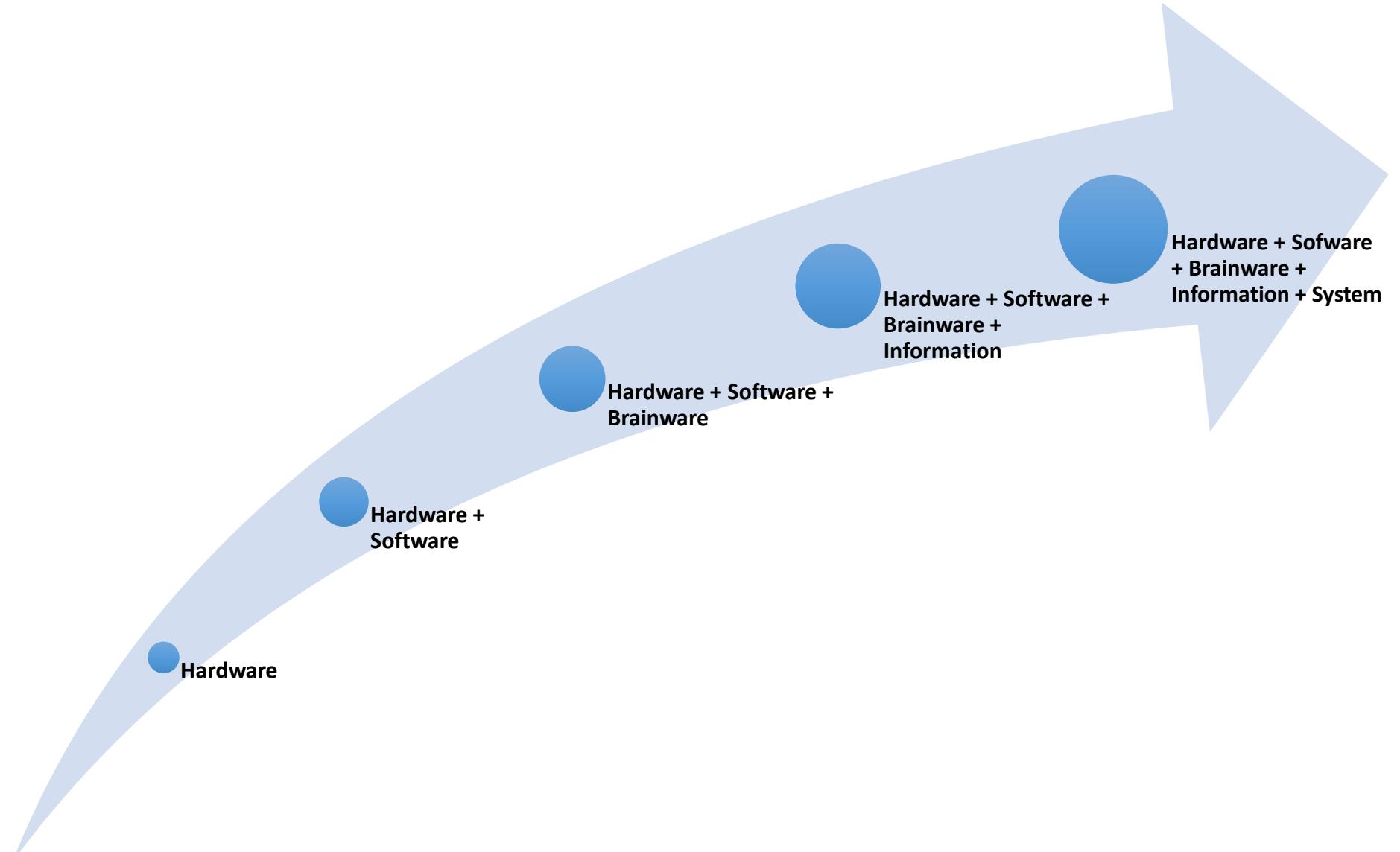
Hasil kajian dan penelitian dalam konteks sejarah ilmu dan taksonominya menempatkan informatika sebagai sebuah ‘rumpun ilmu’ tersendiri yang merupakan bagian dari kelompok “*interdisciplinary science*”.

	Mathematical Science	Physical Science	Biological Science	Psychological Science	Social Science	Linguistic Science	Inter-disciplinary Science	Philosophical Knowledge	Humanities	Science Fiction
Algorithm	H	-	-	-	-	M	H	M	M	M
Computer Application	M	L	L	M	M	L	H	L	M	M
Program Building	H	-	L	L	M	H	H	L	M	H
Computer and Device	H	H	-	-	L	M	H	L	L	M
Human Machine Interaction	M	H	L	M	H	M	H	L	M	M
Information System	M	L	M	M	M	M	H	M	M	M
Data System	H	M	-	M	M	M	H	M	M	M
Computing Resource	H	H	L	L	M	L	H	L	M	H
Intelligent System	H	M	H	H	M	M	H	M	H	H
Networking and Communication	H	H	L	L	-	L	H	L	L	M
System Integration	M	M	M	M	M	M	H	M	M	M

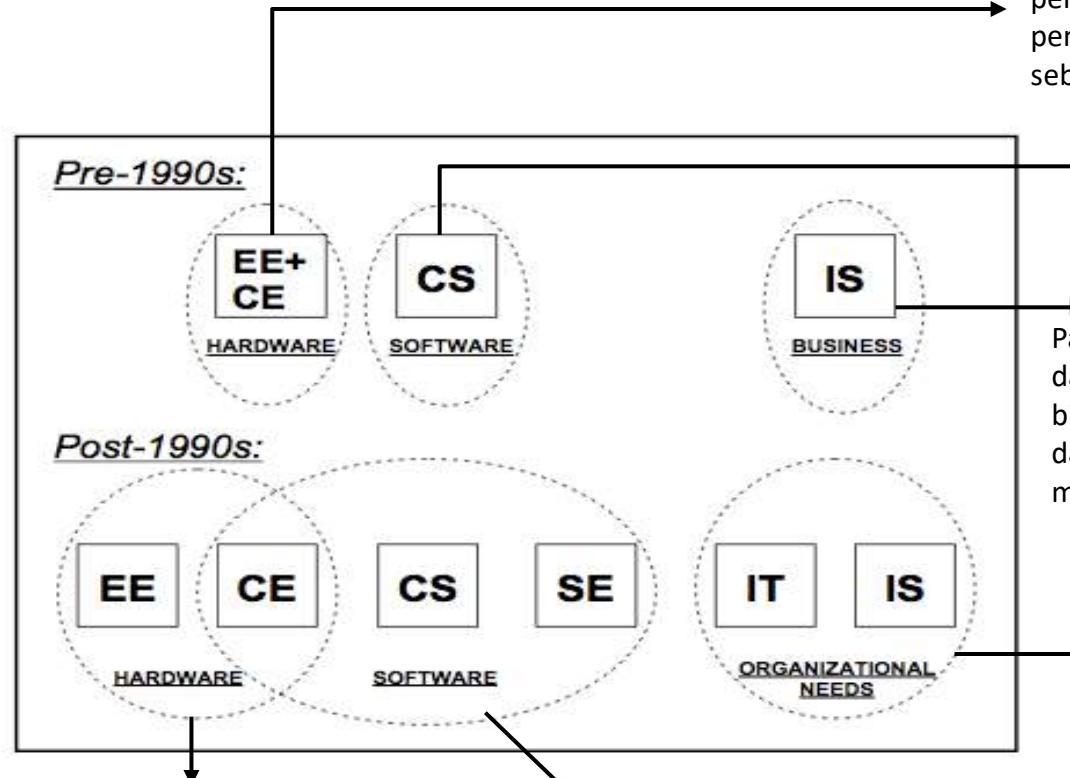
Selama kurang lebih 25 tahun, secara berkala APTIKOM melakukan pertemuan yang melibatkan beragam pemangku kepentingan untuk bertukar pikiran.

- **Asosiasi Industri Pengguna Lulusan:** ASPILUKI (Perangkat Lunak), APKOMINDO (Perangkat Keras), APJII (Internet), AWARI (Warung Internet), IndoWLI (Wireless), I2BC (Bisnis), MASTEL (Telco), IPKIN (Profesi), LSP-Telematika (SDM), IMOCA (Multimedia), KADIN (Perdagangan), ASKISINDO (Konsultan), dan PERBANAS (Bank).
- **Institusi Pemerintah (Regulator):** Depdiknas, Depkominfo, Menristek, Depdagri, Deperindag, Lemhannas, Polri, Kejagung, Bank Indonesia, Lemsaneg, BIN, ID-SIRTII, Dephan, Dephunkam, BSN, dan DepESDM.
- **Asosiasi Internasional:** IEEE, ACM, IASA, ISACA, ITGI, EC-Council, dan OSI.
- **Perguruan Tinggi Regional/Internasional:** Asia (UTM, UKM, NTU, NUS, AIM, AIT), Europe (MSM, U-Cambridge, Oxford), Amerika (MIT, Stanford, GWU, UW-Seattle, CMU), dan Australia (Curtin, Monash, ECU).
- **Lembaga Terkait Lainnya:** JICA, JETRO, USAID, DOJ-USA, OCWC, Open University, PIL, Apconex, APICTAN, ASOCIO, dan lain sebagainya.

Informatika dianggap sebagai rumpun ilmu “**antar bidang**” karena sejarah evolusi dan perkembangannya.



Perkembangan bidang keilmuan yang dinamis telah pula mewarnai platform program studi dan kurikulum yang diterapkan di Indonesia.



Terjadi pemisahan yang tegas antara teknik elektro peminatan komputer dengan baku ilmu teknik komputer yang berbasis digital murni.

Terjadi pemisahan yang tegas antara ilmu informatika yang berbau teoritis dengan yang bersifat aplikatif (didominasi oleh ilmu rekayasa perangkat lunak)

Berasal dari bidang ilmu elektronika, ditujukan bagi mereka yang ingin mengkonsentrasi dirinya pada ilmu dan penerapan teknologi digital (atau perangkat keras). Di sejumlah institusi, masih merupakan salah satu bidang peminatan dari teknik elektronika, sementara di beberapa tempat telah menjadi sebuah program studi tersendiri.

Diperuntukkan bagi mereka yang berniat untuk mempelajari secara mendalam mengenai dasar-dasar teori komputasi dan implementasinya dalam kaitannya dengan komponen-komponen teknologi perangkat keras maupun perangkat lunak. Spektrum bidang ilmu ini sangatlah lebar, mulai dari yang sangat bernuansa matematis dan algoritmik, hingga yang sangat aplikatif di satu titik ekstrim yang lain.

Pada mulanya diperuntukkan bagi mereka yang ingin memiliki pengetahuan dan kompetensi dalam hal penerapan ilmu komputer dan informatika di dunia nyata, seperti dalam entitas bisnis maupun organisasi komersial lainnya. Di luar negeri biasa merupakan bagian dari sekolah atau institusi manajemen dan bisnis (business school) dengan fokus menerapkan "the business value of computer and information technology".

Terjadi pemisahan yang tegas antara "sistem informasi" sebagai sebuah kebutuhan organisasi (sisi DEMAND) dengan Teknologi informasi sebagai infrastruktur atau penunjang Pemenuhan kebutuhan tersebut (sisi SUPPLY)

Saat ini bersepakat untuk mengadopsi Curriculla 2005 sebagai panduan dasar pengembangan kurikulum di bidang komputer dan informatika.

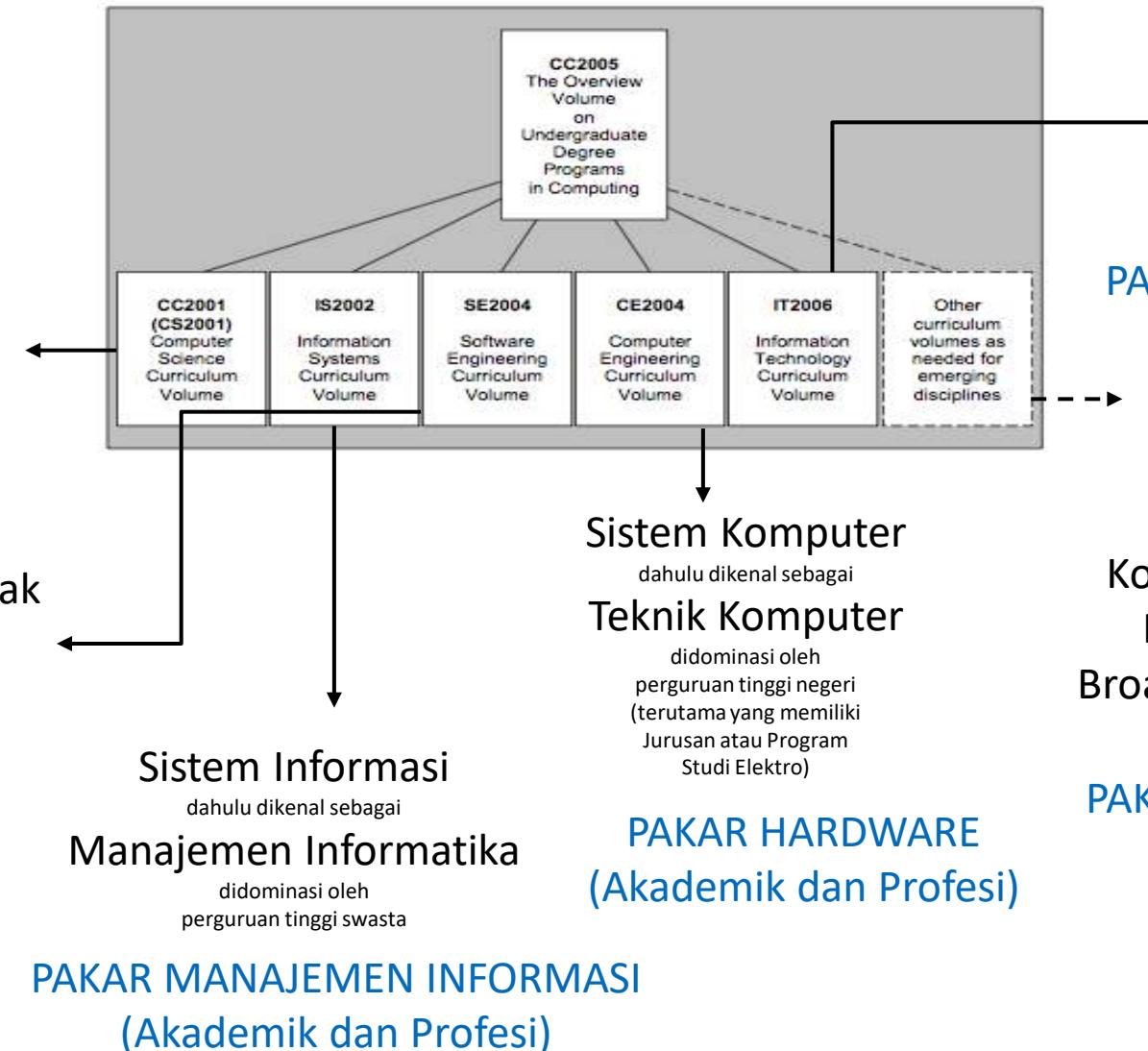
Ilmu Komputer
atau kerap dikenal sebagai
Teknik Informatika

merupakan bidang studi yang paling banyak ditekuni secara seimbang oleh institusi negeri maupun swasta

**PAKAR ALGORITMA
(Akademik)**

Rekayasa Perangkat Lunak
Merupakan bidang studi baru yang ditawarkan, dimana selama ini porsi studinya terkisar dari sebuah mata kuliah hingga menjadi sebuah bidang peminatan

**PAKAR SOFTWARE
(Akademik dan Profesi)**



Teknologi Informatasi

sebagai bidang studi baru yang ditawarkan pada jenjang strata-1 (telah ditawarkan oleh sejumlah institusi swasta maupun negeri untuk jenjang strata-2)

PAKAR INTEGRASI TEKNOLOGI (Akademik dan Profesi)

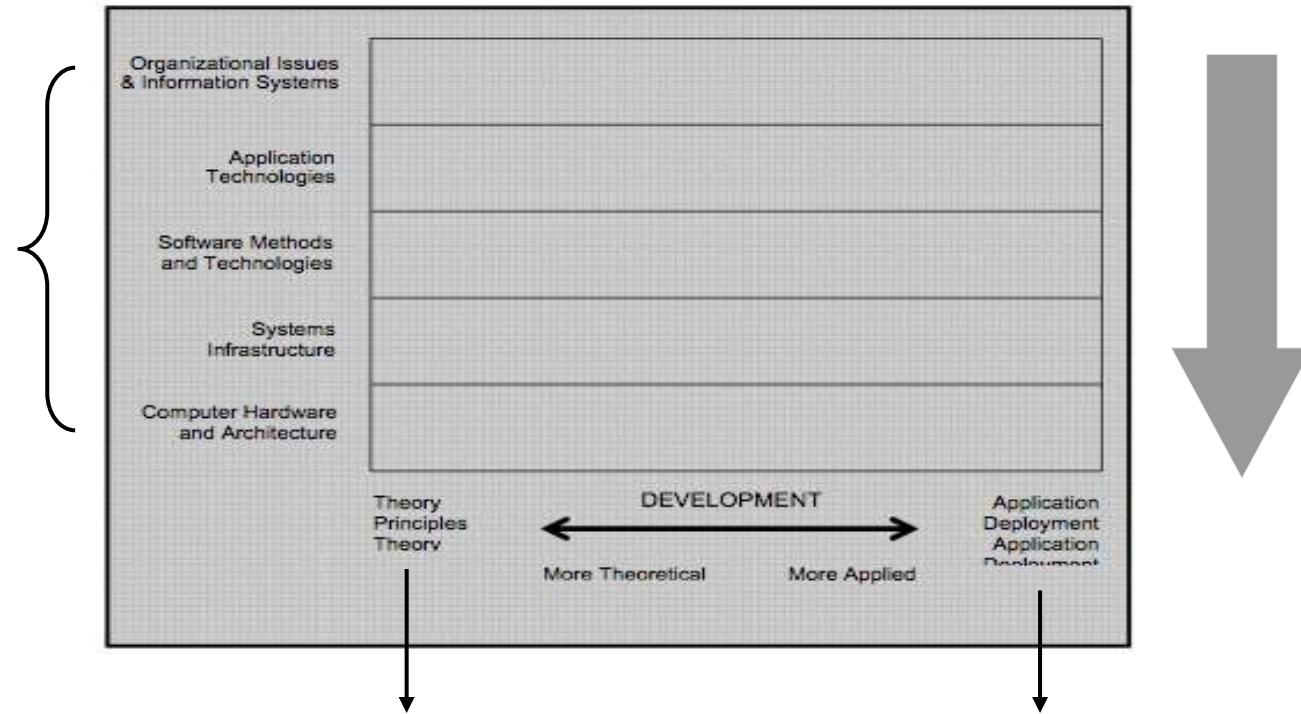
Aneka ragam bidang studi baru yang ditawarkan oleh kebanyakan akademi (tingkat diploma) karena tingginya kebutuhan pasar seperti misalnya:

Komputerisasi Akuntansi, Multimedia, Animasi, Broadcasting, Programming, dan lain sebagainya.

PAKAR APLIKASI TEKNOLOGI (Vokasi dan Profesi)

Secara alami, masing-masing institusi berkonsentrasi pada bidang kompetensi yang menjadi kekuatan yang dimiliki.

Proporsi dan portofolio area keilmuan yang ditekuni sangat ditentukan oleh visi, misi, dan tujuan program studi dan/atau maupun insitusi penyelenggara, terutama dalam kaitannya dengan model Kurikulum Berbasis Kompetensi atau Kurikulum Tingkat Satuan Pendidikan.



Menggambarkan tingkatan atau layer yang semakin ke bawah semakin detail (teknis)

Analogi dengan Kerangka Arsitektur Zachman maupun Model "OSI Seven Layer".

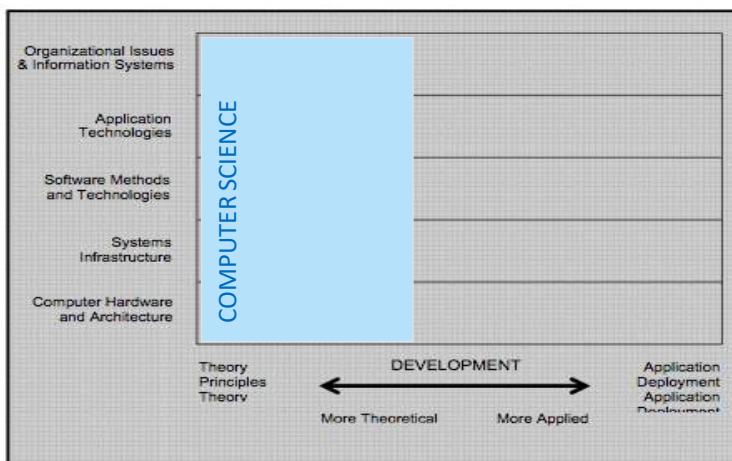
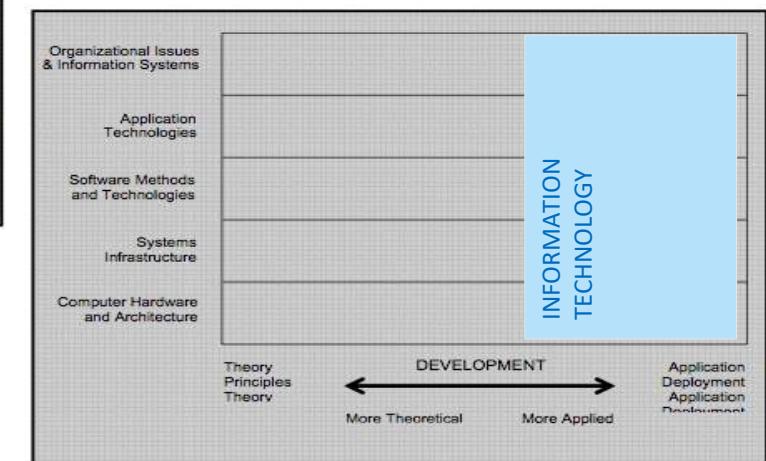
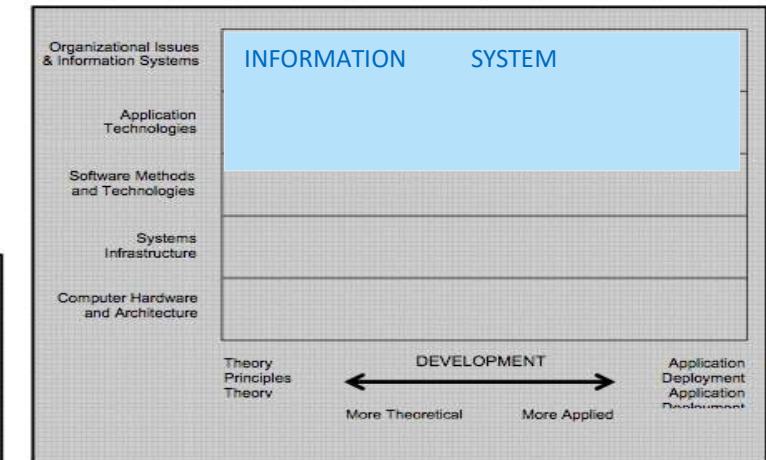
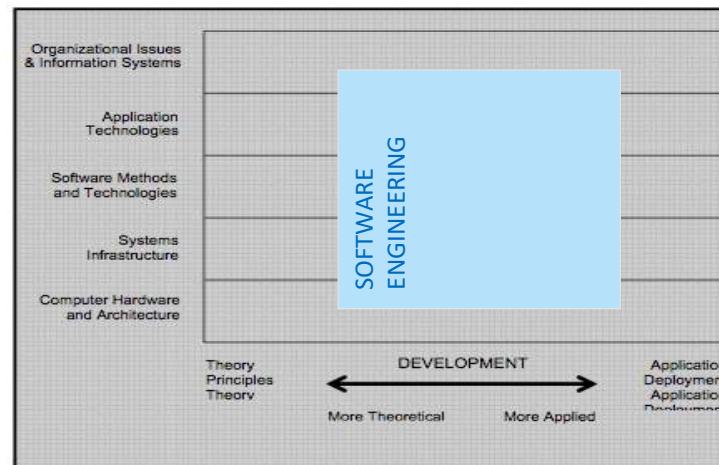
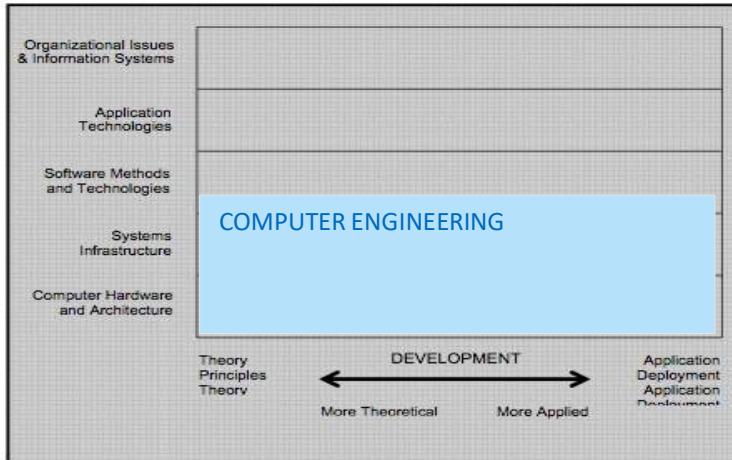
Didominasi oleh perguruan tinggi negeri karena:

- Latar belakang dosennya yang sangat kuat penguasaan teori.
- Karakteristik siswa yang ingin jadi ilmuwan.
- Kesiapan dan ketersediaan laboratorium simulasi pendukung.

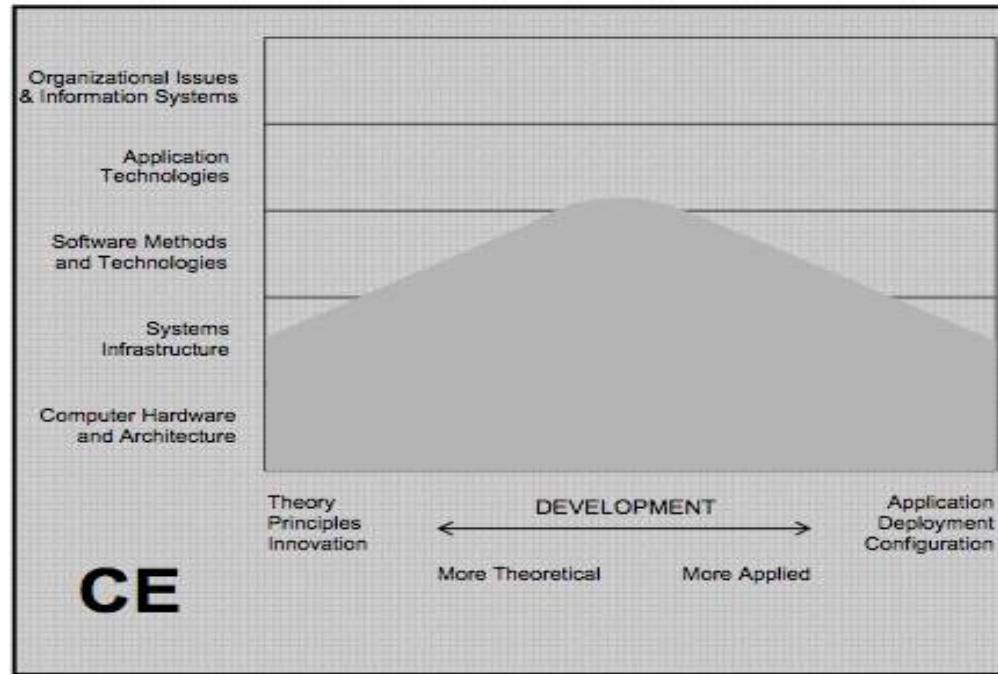
Didominasi oleh perguruan tinggi swasta karena:

- Latar belakang dosennya yang merupakan praktisi lapangan.
- Karakteristik siswa yang ingin jadi pengusaha atau karyawan.
- Kesiapan dan ketersediaan laboratorium industri yang relevan.

Pemetaan kompetensi lulusan memperlihatkan adanya 5 (lima) domain bidang ilmu yang dimaksud.



Program Studi SISTEM KOMPUTER menekankan pada kemampuan individu dalam merancang dan mengembangkan perangkat keras berbasis digital.

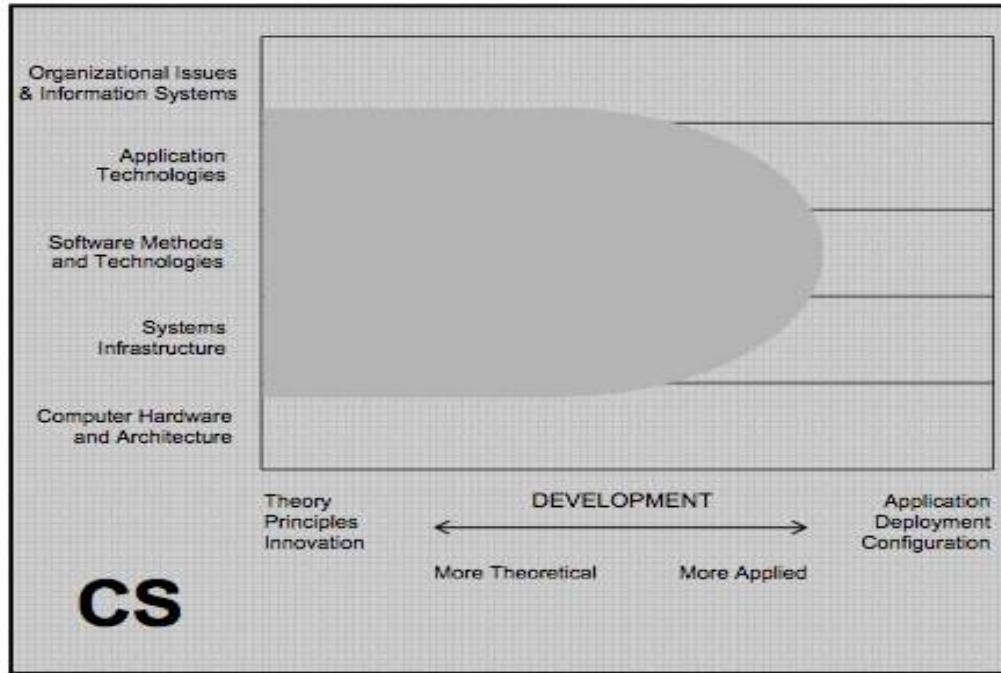


- Terkait dengan desain dan konstruksi sistem berbasis komputer (baca: digital).
- Mencakup studi mengenai perangkat keras, perangkat lunak, teknologi komunikasi, dan interaksi di antara komponen tersebut.
- Kurikulum fokus pada teori, prinsip, dan praktik terpan ilmu elektronika serta matematika, untuk kemudian diimplementasikan dalam bentuk desain komputer atau teknologi lain berbasis digital.
- Belakangan ini berkembang menjadi ilmu yang mempelajari pula cara mendesain beragam peralatan berbasis digital yang banyak ditemui di pasar (*digital gadget*) dan beragam peralatan perangkat keras komunikasi yang banyak dipergunakan dalam jaringan komuter.
- Disamping itu terkait pula dengan studi perancangan komponen berbasis digital (*embedded devices*).

Variasi Nama

Teknik Komputer, Sistem Komputer, Rekayasa Perangkat Keras, Komputerisasi Digital, Ilmu Komputer Digital, Rekayasa Komputer, dan lain sebagainya.

Program Studi ILMU KOMPUTER menekankan pada kemampuan individu dalam merancang dan mengembangkan ragam algoritma komputasi.

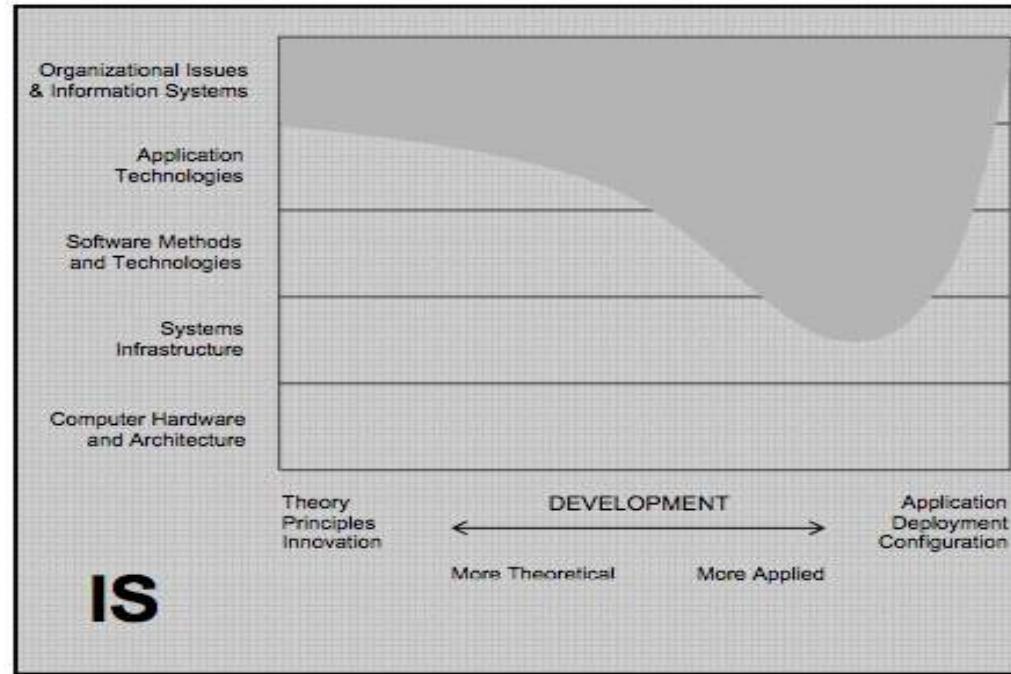


- Spektrumnya sangat beragam dari yang sangat teoritis dan algoritmis, hingga yang bersifat sangat terapan seperti pengembangan robotika dan sistem cerdas.
- Terbagi menjadi tiga bagian utama:
 - Fokus pada teori maupun algoritma yang dipergunakan dalam proses perancangan dan implementasi perangkat lunak.
 - Fokus pada teori maupun algoritma yang dipergunakan dalam proses dan perancangan sistem perangkat keras serta komponennya.
 - Fokus pada teori maupun algoritma yang dipergunakan sebagai model matematis dalam menyelesaikan permasalahan tertentu.
- Kurikulumnya akan sangat kental dengan ilmu pengetahuan terkait dengan logika matematika, komputasi, dan algoritma - yang dalam model terapannya dinyatakan dalam pengembangan program komputer.

Variasi Nama

Teknik Informatika, Ilmu Komputer, Ilmu Komputasi, Informatika, Ilmu Informatika, Matematika Komputasi, dan lain sebagainya.

Program Studi **SISTEM INFORMASI** menekankan pada kemampuan individu dalam merancang, mengembangkan, & menerapkan sistem informasi organisasi.

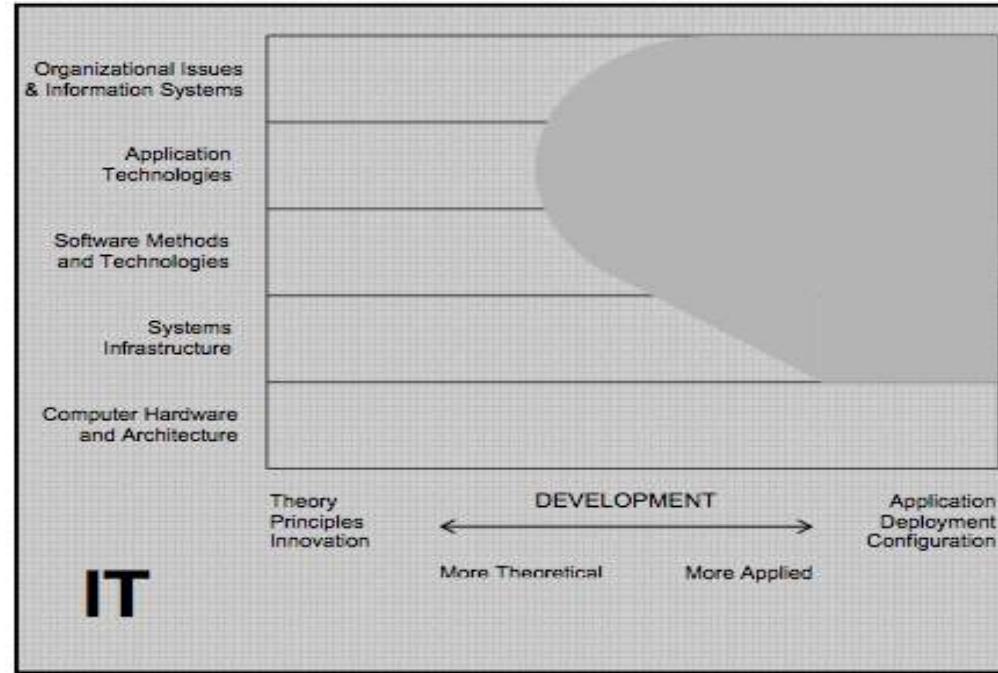


- Fokus pada teknik mengintegrasikan solusi teknologi informasi dengan proses bisnis agar kebutuhan organisasi akan informasi dapat terpenuhi
- Menekankan pada “informasi” sebagai sebuah sumber daya penting dalam berproduksi, terutama dalam kaitannya kebutuhan korporasi dalam pencapaian visi dan misi yang dicanangkan.
- Mempelajari aspek penting bagaimana “informasi” diciptakan, diproses, dan didistribusikan ke seluruh pemangku kepentingan dalam institusi.
- Kurikulum harus ditekankan pada bagaimana memastikan agar teknologi dan sistem informasi yang dimiliki selaras dengan strategi bisnis perusahaan, agar dapat tercipta keunggulan kompetitif dalam bersaing (*the value of information technology to the business*).

Variasi Nama

Sistem Informasi, Manajemen Informatika, Sistem Informasi
Manajemen, Manajemen Sistem Informasi, Manajemen Informasi, dan
lain sebagainya.

Program Studi TEKNOLOGI INFORMASI menekankan pada kemampuan individu dalam merencanakan, menentukan, & mengelola teknologi informasi.

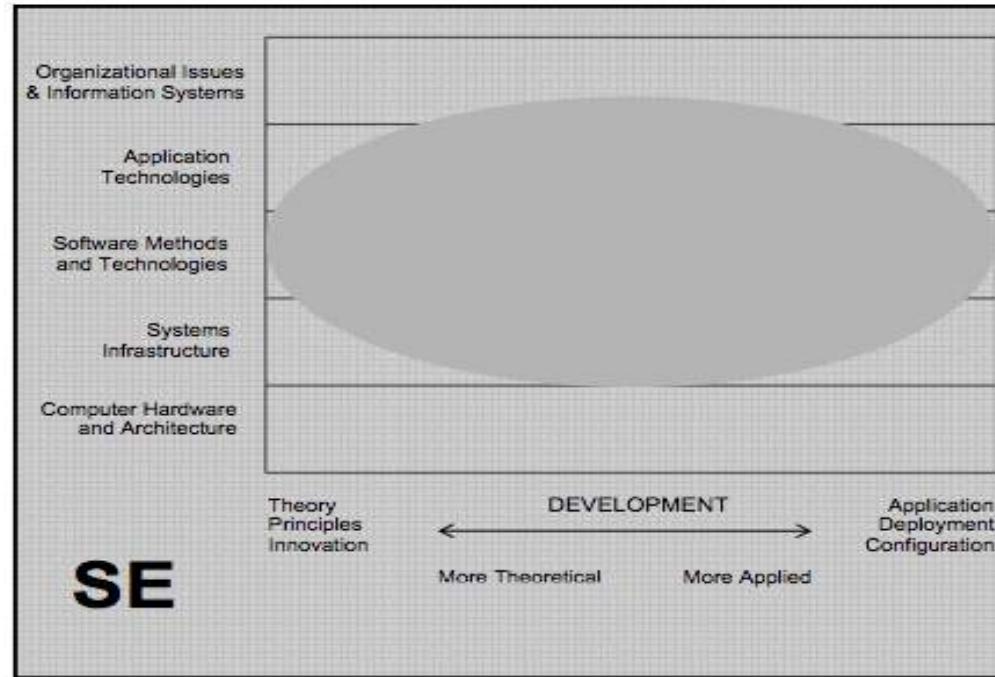


- Berbeda dengan Sistem Informasi yang menekankan pada “informasi”, program studi Teknologi Informasi fokus pada aspek “teknologi” sebagai entitas pemungkinkan (baca: *enabler*) organisasi.
- Menekankan pada proses tata kelola - perencanaan dan organisasi, pengadaan dan implementasi, penerapan dan pemeliharaan, serta pengawasan dan evaluasi - sumber daya teknologi informasi yang ada pada suatu institusi.
- Spektrum fokus kurikulum dari sekedar mempelajari tren teknologi di masa mendatang hingga melakukan “perancangan” ide atau gagasan terhadap inovasi teknologi yang dibutuhkan organisasi.
- Kurikulum akan sangat padat dengan isu tata kelola dan *governance* teknologi informasi.

Variasi Nama

Teknologi Informasi, Teknologi Informasi dan Komunikasi, Teknik Informasi, Telematika, Teknologi Informatika, dan lain sebagainya.

Program Studi REKAYASA PERANGKAT LUNAK menekankan pada kemampuan siswa dalam merancang dan mengembangkan software.

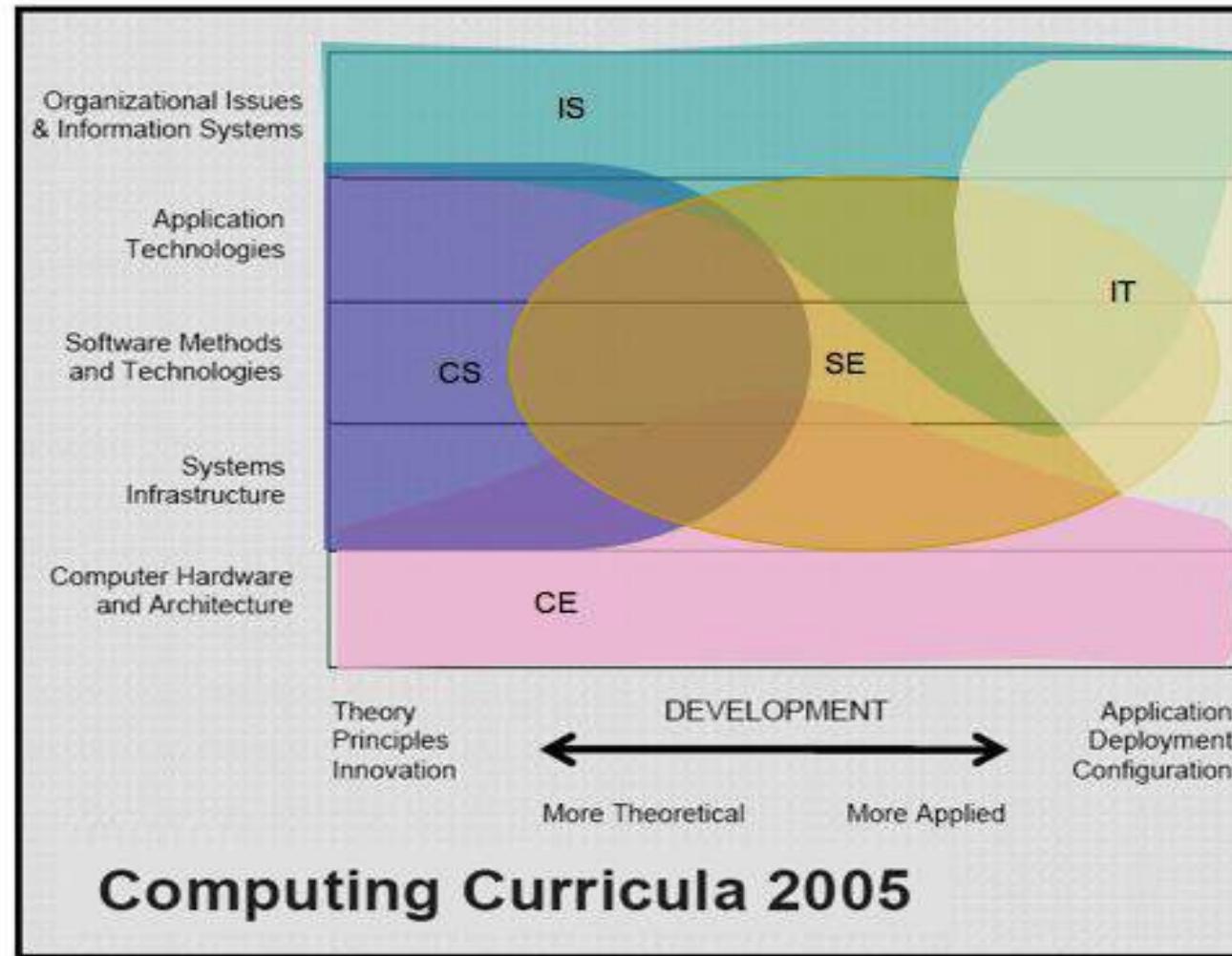


- Sebagai hal yang paling banyak dibutuhkan industri, studi ini menekankan pada pengembangan dan penerapan metodologi pembuatan perangkat lunak dengan kualitas prima.
- Fokus pada pengembangan model sistematis dan terpercaya, yang harus dipergunakan sebagai panduan dalam mengembangkan berbagai jenis perangkat lunak.
- Selain perangkat lunak aplikasi, mencakup pula pengetahuan mengenai bagaimana membangun sebuah perangkat lunak sistem (*system software*) dan perangkat lunak penunjang (*tool software*).
- Disamping itu dibekali pula akan ilmu yang terkait dengan seluk beluk infrastruktur di satu sisi, dan sistem informasi di sisi lainnya - karena kedua komponen tersebut merupakan entitas penting yang berada dalam ruang lingkup pengembangan perangkat lunak.

Variasi Nama

Rekayasa Perangkat Lunak, Rekayasa Software, Programming, Pengembangan Software, dan lain sebagainya.

Computing Curricula 2005 mempertegas karakteristik khusus teritori ilmu informatika dipandang dari kompetensi kognitif.



- ALGORITHM
- COMPUTER APPLICATION
- PROGRAM BUILDING
- COMPUTER & DEVICE
- HUMAN MACHINE INTERACTION
- INFORMATION SYSTEM
- DATA SYSTEM
- COMPUTING RESOURCE
- INTELLIGENT SYSTEM
- NETWORKING & COMMUNICATION
- SYSTEM INTEGRATION

“... kesebelas kompetensi dan knowledge objects inilah yang membedakan bidang studi pada rumpun ilmu informatika dan komputer dengan bidang studi lain yang memiliki informatika atau komputer sebagai bidang peminatan atau konsentrasi studi ...”

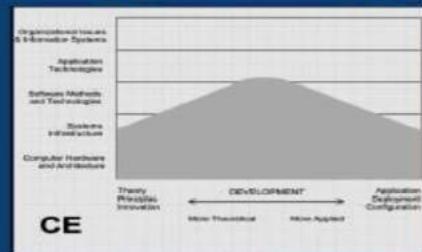
Poster Explaining CC2005 Curricular Visuals

The Computing Field

Computing—the goal-oriented activity that requires, benefits from, or creates computers—is a vibrant and challenging academic and professional field. The expansion and evolution of computing led to the specialization of knowledge and the emergence of several related, but quite different from each other, computing disciplines. In order to improve understanding of this family of disciplines by newcomers, but also among computing practitioners, the Association for Computing Machinery (ACM), the Association for Information Systems (AIS)

and the Computer Society of the Institute for Electrical and Electronic Engineers (IEEE-CS) have sponsored a set of reports that point out the commonalities and differences between the computing disciplines. This poster provides a synthetic interpretation of those reports, highlighting the problem space scope, main knowledge areas and core performance capabilities of each of the five major computing disciplines: computer engineering, computer science, information systems, information technology, and software engineering.

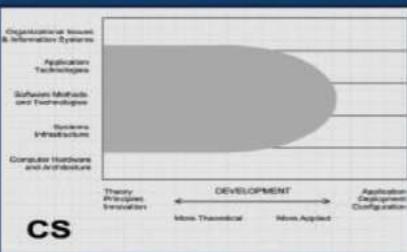
Computer Engineering



Computer architecture & organization
Computer systems engineering
Digital logic
Programming fundamentals
Distributed systems
Circuits & systems
Electronics

Design and implement computing systems, computer-controlled equipment and communication software
Maintain computing systems that involve the integration of software and hardware devices

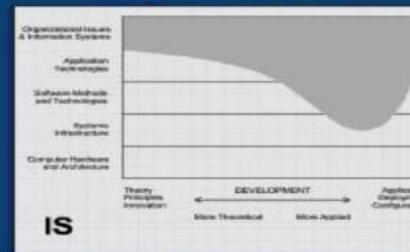
Computer Science



Software development fundamentals
Algorithms & complexity
Software engineering
Programming languages
Discrete structures
Systems fundamentals
Computer architecture & organization

Design & implement software
Develop solutions to computing problems
Optimize programming solutions
Prove theoretical results
Devise new ways to use computers

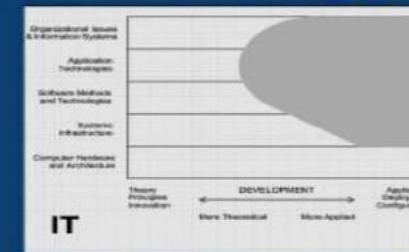
Information Systems



Foundations of information systems
Data & information management
Information systems strategy, management & acquisition
Enterprise architecture
Systems analysis & design
Information technology infrastructure
Project management

Improve organizational processes
Exploit technological innovations
Define information requirements
Design enterprise architecture
Secure data & infrastructure
Manage information systems risks

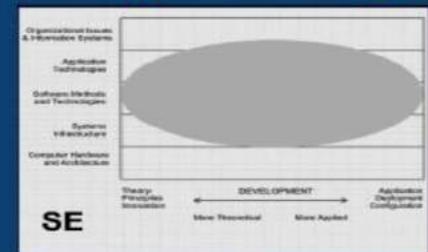
Information Technology



Technical support
Programming fundamentals
Information management
Information technology fundamentals
Systems integration
Mathematical fundamentals
Interpersonal communication

Train and support users
Plan, select, configure & maintain information systems infrastructure
Model, design, select, configure & manage databases
Configure & integrate business applications

Software Engineering



Computing essentials
Software modeling & analysis
Software design
Software verification & validation
Professional practice
Mathematical & engineering fundamentals
Project management

Do small-scale & large-scale programming
Develop software systems
Manage software projects
Implement information systems
Define information systems technical requirements

Sources

- CC (2006). Computing Curricula 2005 – The Overview Report. ACM, AIS and IEEE-CS.
- CE (2004). Curriculum Guidelines for Undergraduate Degree Programs in Computer Engineering. IEEE-CS and ACM.
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- IS (2010). Curriculum Guidelines for Undergraduate Degree Programs in Information Systems. ACM and AIS.
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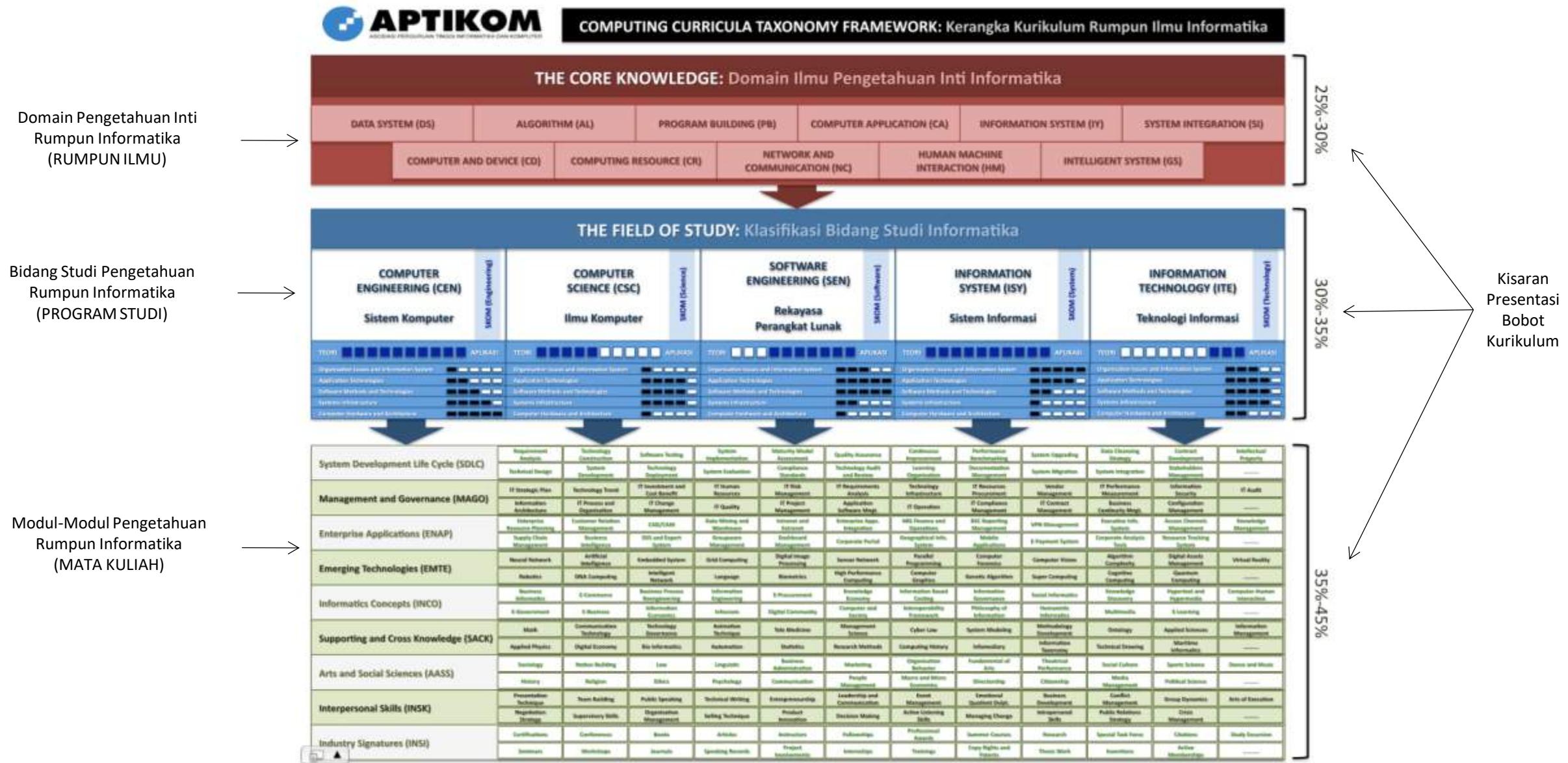
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Terdapat 7 (tujuh) tantangan utama dalam menyusun Kurikulum Rumpun Ilmu Informatika yang relevan, berkualitas, dan adaptif.

1. Karena perubahan kebutuhan dan teknologi yang terjadi sangatlah cepat, maka model kurikulum yang dikembangkan haruslah **adaptif**;
2. Karena kondisi Indonesia yang sangat **heterogen**, maka perlu disusun model kurikulum yang kaya dan **bervariasi** dalam memenuhi beraneka ragam kebutuhan tersebut;
3. Karena masing-masing perguruan tinggi memiliki **ciri khas** dan **potensi kekuatan** yang berbeda-beda, maka model penyelenggaraan pendidikan yang dilakukan harus dapat mengembangkan potensi yang dimaksud;
4. Karena sebagai sebuah unsur penyelenggara pendidikan tinggi perlu diperhatikan strategi manajemen agar terjadi proses kerja yang **berkesinambungan** dan **kontinyu** dari masa ke masa (baca: **sustainable**), maka program yang dikembangkan haruslah menarik calon peserta didik;
5. Karena setiap perguruan tinggi bercita-cita untuk selalu **mengembangkan** institusi pendidikannya (baca: **scalable**), maka model kurikulum yang ada haruslah mudah direplikasi;
6. Karena unsur **kualitas** harus tetap menjadi aspek yang diperhatikan secara sungguh-sungguh, maka pendekatan pembuatan kurikulum juga perlu memperhatikan kaidah-kaidah pedagogis yang dapat dipertahankan (baca: **defensable**); dan
7. Karena era globalisasi ini terjadi persaingan yang ketat berbasis lintas negara, maka kurikulum yang dikembangkan harus mampu menghasilkan lulusan yang siap berpartisipasi dalam lingkungan kerja **internasional**.

Kurikulum APTIKOM 2008 disusun berdasarkan konsep “**Multi Source Learning**” yang mengacu pada standar ‘best practice’ internasional yang modular dengan tetap mempertahankan dinamika kebutuhan lokal/nasional



Domain Pertama terdiri dari kumpulan area pengetahuan untuk membangun 11 dasar ilmu di bidang informatika dan komputer.

1. **Data System (DS)** – terkait dengan pengetahuan yang mempelajari sistem ke-“data”-an sebagai atom konteks terkecil dalam sebuah lingkungan berbasis informatika;
2. **Algorithm (AL)** – terkait dengan pengetahuan berfikir secara logis dan terstruktur dalam rangka memecahkan permasalahan tertentu atau mencapai obyektif tertentu;
3. **Program Building (PB)** – terkait dengan kemampuan membangun program sebagai suatu perangkat lunak yang dapat menjalankan fungsi spesifik tertentu;
4. **Computer Application (CA)** – terkait dengan pengetahuan dan kemampuan menggabungkan sejumlah modul-modul program dalam rangka membuat sebuah aplikasi dengan fitur-fitur yang diinginkan;
5. **Information System (IY)** – terkait dengan pengetahuan membangun sebuah sistem informasi yang terdiri dari komponen-komponen yang terkait satu dengan lainnya dalam sebuah lingkungan yang holistik;
6. **System Integration (SI)** – terkait dengan kemampuan membangun sebuah sistem terpadu yang terdiri dari berbagai jenis sistem informasi yang berbeda-beda dalam sebuah lingkungan yang sama;
7. **Computer and Device (CD)** – terkait dengan pemahaman terhadap cara kerja mesin komputasi beserta piranti lain pendukungnya;
8. **Computing Resource (CR)** – terkait dengan pengetahuan mengenai cara kerja setiap komponen-komponen atau sumber daya-sumber daya komputasi;
9. **Network and Communication (NC)** – terkait dengan pengetahuan mengenai seluk beluk jejaring komputer beserta mekanisme protokol komunikasinya;
10. **Human Machine Interaction (HM)** – terkait dengan pengetahuan merancang dan membangun sistem antarmuka yang menghubungkan manusia dengan “mesin komputasi” (baca: komputer); dan
11. **Intelligent System (GS)** – terkait dengan pemahaman dalam merancang dan membangun sistem cerdas untuk berbagai kebutuhan aktivitas kehidupan manusia yang memberikan nilai tambah.

Domain Kedua berisi kumpulan 40 area pengetahuan sesuai dengan bidang studi yang ingin ditekuni dengan model pembobotan yang berbeda-beda.

Knowledge Area	CE		CS		IS		IT		SE	
	min	max								
Programming Fundamentals	4	4	4	5	2	4	2	4	5	5
Integrative Programming	0	2	1	3	2	4	3	5	1	3
Algorithms and Complexity	2	4	4	5	1	2	1	2	3	4
Computer Architecture and Organization	5	5	2	4	1	2	1	2	2	4
Operating Systems Principles & Design	2	5	3	5	1	1	1	2	3	4
Operating Systems Configuration & Use	2	3	2	4	2	3	3	5	2	4
Net Centric Principles and Design	1	3	2	4	1	3	3	4	2	4
Net Centric Use and configuration	1	2	2	3	2	4	4	5	2	3
Platform technologies	0	1	0	2	1	3	2	4	0	3
Theory of Programming Languages	1	2	3	5	0	1	0	1	2	4
Human-Computer Interaction	2	5	2	4	2	5	4	5	3	5
Graphics and Visualization	1	3	1	5	1	1	0	1	1	3
Intelligent Systems (AI)	1	3	2	5	1	1	0	0	0	0
Information Management (DB) Theory	1	3	2	5	1	3	1	1	2	5
Information Management (DB) Practice	1	2	1	4	4	5	3	4	1	4
Scientific computing (Numerical mthds)	0	2	0	5	0	0	0	0	0	0
Legal / Professional / Ethics / Society	2	5	2	4	2	5	2	4	2	5
Information Systems Development	0	2	0	2	5	5	1	3	2	4
Analysis of Business Requirements	0	1	0	1	5	5	1	2	1	3
E-business	0	0	0	0	4	5	1	2	0	3
Analysis of Technical Requirements	2	5	2	4	2	4	3	5	3	5
Engineering Foundations for SW	1	2	1	2	1	1	0	0	2	5
Engineering Economics for SW	1	3	0	1	1	2	0	1	2	3
Software Modeling and Analysis	1	3	2	3	3	3	1	3	4	5
Software Design	2	4	3	5	1	3	1	2	5	5
Software Verification and Validation	1	3	1	2	1	2	1	2	4	5
Software Evolution (maintenance)	1	3	1	1	1	2	1	2	2	4
Software Process	1	1	1	2	1	2	1	1	2	5
Software Quality	1	2	1	2	1	2	1	2	2	4
Comp Systems Engineering	5	5	1	2	0	0	0	0	2	3
Digital logic	5	5	2	3	1	1	1	1	0	3
Embedded Systems	2	5	0	3	0	0	0	1	0	4
Distributed Systems	3	5	1	3	2	4	1	3	2	4
Security: issues and principles	2	3	1	4	2	3	1	3	1	3
Security: implementation and mgt	1	2	1	3	1	3	3	5	1	3
Systems administration	1	2	1	1	1	3	3	5	1	2
Management of Info Systems Org.	0	0	0	0	3	5	0	0	0	0
Systems integration	1	4	1	2	1	4	4	5	1	4
Digital media development	0	2	0	1	1	2	3	5	0	1
Technical support	0	1	0	1	1	3	5	5	0	1

“dapat dipergunakan untuk menentukan bobot minimum dan maksimum SKS yang ingin dibebankan pada mata kuliah terkait”

“bidang studi yang ingin ditekuni”

Domain Ketiga berisi kumpulan 9 area terkait dengan aspek kognitif, afektif, dan psikomotorik sebagai referensi komponen lokal yang adaptif.

1. **System Development Life Cycle (SDLC)** – merupakan kumpulan dari berbagai modul ilmu pengetahuan yang terkait dengan pengembangan sebuah sistem atau entitas komputasi (sistem informasi, teknologi informasi, komputer, perangkat lunak, dan lain-lain), seperti: Analisa Kebutuhan, Desain Sistem, Model Implementasi, Audit Teknologi, dan lain sebagainya;
2. **Management and Governance (MAGO)** – merupakan kumpulan dari berbagai modul ilmu pengetahuan yang terkait dengan aktivitas perencanaan, penerapan, pengelolaan, dan pengawasan (baca: manajemen) ragam entitas perangkat informasi, seperti: Perencanaan Strategis TI, Manajemen Kualitas Software, Tata Kelola Organisasi TI, dan lain sebagainya;
3. **Enterprise Applications (ENAP)** – merupakan kumpulan dari berbagai modul ilmu pengetahuan yang terkait dengan aplikasi perangkat teknologi informasi dalam kehidupan manusia sehari-hari, seperti: Manajemen Rantai Pasokan (*Supply Chain Management*), *Enterprise Resource Planning*, *Customer Relationship Management*, Intranet dan Ekstranet, *Corporate Datawarehouse*, Sistem Informasi Manajemen, dan lain sebagainya;
4. **Emerging Technologies (EMTE)** – merupakan kumpulan dari berbagai modul ilmu pengetahuan yang terkait dengan produk-produk atau konsep-konsep termutakhir (baca: *state-of-the-art*) di dunia teknologi informasi dan komunikasi, seperti: *Neural Network*, *Fuzzy Logic*, *Grid Computing*, *Parallel Architecture*, *Complexity of Algorithm*, *Quantum Computing*, *Expert System*, dan lain sebagainya;
5. **Informatics Concepts (INCO)** – merupakan kumpulan dari berbagai modul ilmu pengetahuan yang terkait dengan penerapan konsep-konsep informatika di berbagai aspek kehidupan masyarakat luas, seperti: *E-Government*, *E-Learning*, *E-Business*, *E-Procurement*, *Digital Community*, *Cyber Economics*, *Bio Informatics*, dan lain sebagainya;
6. **Supporting and Core Knowledge (SACK)** – merupakan kumpulan dari berbagai modul ilmu pengetahuan non informatika yang secara pedagogis menjadi penunjang utama ilmu informatika, seperti: Aljabar Linier, Matematika Terapan, Pengantar Statistik, Fisika, Elektronika Dasar, Manajemen Umum, Riset Operasional, Metodologi Penelitian, dan lain sebagainya;
7. **Arts and Social Sciences (AASS)** - berbagai konsep informatika, seperti: Psikologi Organisasi, Sosiologi, Teori Komunikasi, Pengantar Ilmu Hukum, Etika Profesi, dan lain sebagainya;
8. **Interpersonal Skills (INSK)** – merupakan kumpulan dari berbagai modul ilmu pengetahuan untuk meningkatkan kompetensi afektif dan psiko-motorik seseorang (baca: *soft skills*), seperti: *Team Building*, *Presentation Skills*, Teknik Negosiasi, Manajemen Perubahan, *Conflict Resolution*, Teori Kepemimpinan (*Leadership*), dan lain sebagainya; dan
9. **Industry Signatures (INSI)** – merupakan kumpulan dari berbagai modul ilmu pengetahuan yang berasal dari bentuk atau format yang merepresentasikan dunia industri informatika, atau hubungan keterkaitan antara peserta didik serta karya-karyanya dengan pihak eksternal perguruan tinggi, seperti: Kerja Praktek (Magang), Skripsi, Sertifikasi Profesi, Manajemen Proyek Mandiri, Laboratorium Industri, Seminar/Konferensi, dan lain sebagainya.

Contoh Kurikulum Sistem Komputer

Semester 1

Kode	Nama Matakuliah	SKS
DS	Data System	3
AL	Algorithm	3
PB	Program Building	3
CA	Computer Application	3
CE1	IT Trend	3
SDLC	Numerical Methods	3
	Total	18

Semester 2

Kode	Nama Matakuliah	SKS
IY	Information System	3
SI	System Integration	3
CD	Computer & Device	3
CR	Computing Resource	3
CE2	Digital System	3
MAGO	IT Governance	3
	Total	18

Semester 3

Kode	Nama Matakuliah	SKS
NC	Network Comm.	4
CE3	IT Architecture	4
CE4	Net Operating System	3
CE5	Micro Programming	3
CE6	Computer Org.	2
ENAP	Cloud Computing	2
	Total	18

Semester 4

Kode	Nama Matakuliah	SKS
HM	Human-Machine Inter.	3
CE7	Platform Technology	3
CE8	Net Centric Principles	3
CE9	Distributed System	3
CE10	Engineering Basic	3
EMTE	Grid Computing	3
	Total	18

Semester 5

Kode	Nama Matakuliah	SKS
GS	Intelligent System	3
CE11	System Engineering	4
CE12	Embedded System	2
CE13	System Integration	3
CE14	Quality Management	3
INCO	Green Computing	3
	Total	18

Semester 6

Kode	Nama Matakuliah	SKS
CE15	Security Management	3
CE16	Multimedia Environ.	3
CE17	Engineering Economic	3
CE18	System Development	3
CE19	Intelligent System	3
SACK	Research Methods	3
	Total	18

Semester 7

Kode	Nama Matakuliah	SKS
CE20	CAD/CAM Utility	3
CE21	Industry Standard	3
CE22	Mechatronics	3
CE23	Engineering Project	3
INSK1	Professional Ethics	3
AASS	Communication Skills	3
	Total	18

Semester 8

Kode	Nama Matakuliah	SKS
CE24	Emerging IT Trend	2
INSK2	Team Building	2
INSI1	Seminars	2
INSI2	Company Internship	3
INSK3	Technopreneurship	3
INSI3	Thesis	6
		18

Contoh Kurikulum Ilmu Komputer

Semester 1

Kode	Nama Matakuliah	SKS
DS	Data System	3
AL	Algorithm	3
PB	Program Building	3
CA	Computer Application	3
CS1	Digital Mathematics	3
SDLC	Numerical Methods	3
	Total	18

Semester 2

Kode	Nama Matakuliah	SKS
IY	Information System	3
SI	System Integration	3
CD	Computer & Device	3
CR	Computing Resource	3
CS2	Automation System	3
MAGO	IT Governance	3
	Total	18

Semester 3

Kode	Nama Matakuliah	SKS
NC	Network Comm.	4
CS3	Computer Org.	4
CS4	Operating System	3
CS5	Program. Languages	3
CS6	Complexity Math.	2
ENAP	Cloud Computing	2
	Total	18

Semester 4

Kode	Nama Matakuliah	SKS
HM	Human-Machine Inter.	3
CS7	System Development	3
CS8	Parallel Computing	3
CS9	Statistical Methods	3
CS10	Scientific Computing	3
EMTE	Grid Computing	3
	Total	18

Semester 5

Kode	Nama Matakuliah	SKS
GS	Intelligent System	3
CS11	Artificial Intelligence	4
CS12	Management Science	2
CS13	System Integration	3
CS14	Quality Management	3
INCO	Green Computing	3
	Total	18

Semester 6

Kode	Nama Matakuliah	SKS
CS15	Security Management	3
CS16	Multimedia Environ.	3
CS17	System Economics	3
CS18	System Development	3
CS19	Adaptive Algorithm	3
SACK	Research Methods	3
	Total	18

Semester 7

Kode	Nama Matakuliah	SKS
CS20	Trend in CS Research	3
CS21	Industry Standard	3
CS22	Mechatronics	3
CS23	Metrics Management	3
INSK1	Professional Ethics	3
AASS	Communication Skills	3
	Total	18

Semester 8

Kode	Nama Matakuliah	SKS
CS24	Emerging CS Trend	2
INSK2	Team Building	2
INSI1	Seminars	2
INSI2	Company Internship	3
INSK3	Technopreneurship	3
INSI3	Thesis	6
		18

Contoh Kurikulum Sistem Informasi

Semester 1

Kode	Nama Matakuliah	SKS
DS	Data System	3
AL	Algorithm	3
PB	Program Building	3
CA	Computer Application	3
IS1	ICT Global Trend	3
SDLC	Numerical Methods	3
	Total	18

Semester 2

Kode	Nama Matakuliah	SKS
IY	Information System	3
SI	System Integration	3
CD	Computer & Device	3
CR	Computing Resource	3
IS2	Information Mngt.	3
MAGO	IT Governance	3
	Total	18

Semester 3

Kode	Nama Matakuliah	SKS
NC	Network Comm.	4
IS3	IS Development	4
IS4	Operating System	3
IS5	Basic Programming	3
IS6	Computer Org.	2
ENAP	Cloud Computing	2
	Total	18

Semester 4

Kode	Nama Matakuliah	SKS
HM	Human-Machine Inter.	3
IS7	IS Management	3
IS8	Net Centric Principles	3
IS9	Virtual Organisation	3
IS10	Taxonomy & Ontology	3
EMTE	Grid Computing	3
	Total	18

Semester 5

Kode	Nama Matakuliah	SKS
GS	Intelligent System	3
IS11	Requirements Mngt.	4
IS12	IS Audit	2
IS13	System Integration	3
IS14	Quality Management	3
INCO	Green Computing	3
	Total	18

Semester 6

Kode	Nama Matakuliah	SKS
IS15	Information Security	3
IS16	Multimedia System	3
IS17	IS Project Mngt.	3
IS18	Holistic Management	3
IS19	Intelligent System	3
SACK	Research Methods	3
	Total	18

Semester 7

Kode	Nama Matakuliah	SKS
IS20	System Integration	3
IS21	Change Management	3
IS22	National Info. System	3
IS23	E-Business Strategy	3
INSK1	Professional Ethics	3
AASS	Communication Skills	3
	Total	18

Semester 8

Kode	Nama Matakuliah	SKS
IS24	Future Organisation	2
INSK2	Team Building	2
INSI1	Seminars	2
INSI2	Company Internship	3
INSK3	Technopreneurship	3
INSI3	Thesis	6
		18

Contoh Kurikulum Rekayasa Piranti Lunak

Semester 1

Kode	Nama Matakuliah	SKS
DS	Data System	3
AL	Algorithm	3
PB	Program Building	3
CA	Computer Application	3
SE1	IT Software Trend	3
SDLC	Numerical Methods	3
	Total	18

Semester 2

Kode	Nama Matakuliah	SKS
IY	Information System	3
SI	System Integration	3
CD	Computer & Device	3
CR	Computing Resource	3
SE2	Software DLC	3
MAGO	IT Governance	3
	Total	18

Semester 3

Kode	Nama Matakuliah	SKS
NC	Network Comm.	4
SE3	System Architecture	4
SE4	Net Operating System	3
SE5	Complexity Math.	3
SE6	Computer Org.	2
ENAP	Cloud Computing	2
	Total	18

Semester 4

Kode	Nama Matakuliah	SKS
HM	Human-Machine Inter.	3
SE7	Platform Technology	3
SE8	Net Centric Principles	3
SE9	Distributed System	3
SE10	Software Develop.	3
EMTE	Grid Computing	3
	Total	18

Semester 5

Kode	Nama Matakuliah	SKS
GS	Intelligent System	3
SE11	Analysis Mngt.	4
SE12	Software Design	2
SE13	Integration Mngt.	3
SE14	Software Architecture	3
INCO	Green Computing	3
	Total	18

Semester 6

Kode	Nama Matakuliah	SKS
SE15	Development Mngt.	3
SE16	Secure Programming	3
SE17	Engineering Economic	3
SE18	Quality Assurance	3
SE19	Intelligent System	3
SACK	Research Methods	3
	Total	18

Semester 7

Kode	Nama Matakuliah	SKS
SE20	Software Maintenance	3
SE21	Industry Standard	3
SE22	System Software	3
SE23	Software Project Mng.	3
INSK1	Professional Ethics	3
AASS	Communication Skills	3
	Total	18

Semester 8

Kode	Nama Matakuliah	SKS
SE24	Software Audit	2
INSK2	Team Building	2
INSI1	Seminars	2
INSI2	Company Internship	3
INSK3	Technopreneurship	3
INSI3	Thesis	6
		18

Contoh Kurikulum Teknologi Informasi

Semester 1

Kode	Nama Matakuliah	SKS
DS	Data System	3
AL	Algorithm	3
PB	Program Building	3
CA	Computer Application	3
IT1	Technology Trend	3
SDLC	Numerical Methods	3
	Total	18

Semester 2

Kode	Nama Matakuliah	SKS
IY	Information System	3
SI	System Integration	3
CD	Computer & Device	3
CR	Computing Resource	3
IT2	IT Applications Model	3
MAGO	IT Governance	3
	Total	18

Semester 3

Kode	Nama Matakuliah	SKS
NC	Network Comm.	4
IT3	IT System Architecture	4
IT4	Net Operating System	3
IT5	Integrative Technology	3
IT6	Computing Mngt.	2
ENAP	Cloud Computing	2
	Total	18

Semester 4

Kode	Nama Matakuliah	SKS
HM	Human-Machine Inter.	3
IT7	Platform Technology	3
IT8	Net Centric Principles	3
IT9	Distributed System	3
IT10	Information Mngt.	3
EMTE	Grid Computing	3
	Total	18

Semester 5

Kode	Nama Matakuliah	SKS
GS	Intelligent System	3
IT11	System Engineering	4
IT12	Technology Policy	2
IT13	E-Business System	3
IT14	Quality Management	3
INCO	Green Computing	3
	Total	18

Semester 6

Kode	Nama Matakuliah	SKS
IT15	IT Project Mngt.	3
IT16	IT-Related Techno.	3
IT17	Engineering Economic	3
IT18	System Development	3
IT19	Intelligent System	3
SACK	Research Methods	3
	Total	18

Semester 7

Kode	Nama Matakuliah	SKS
IT20	IT Cost-Benefit	3
IT21	IT Industry Standard	3
IT22	IT National Architect.	3
IT23	Embedded Techno.	3
INSK1	Professional Ethics	3
AASS	Communication Skills	3
	Total	18

Semester 8

Kode	Nama Matakuliah	SKS
IT24	Emerging IT Trend	2
INSK2	Team Building	2
INSI1	Seminars	2
INSI2	Company Internship	3
INSK3	Technopreneurship	3
INSI3	Thesis	6
		18

Extensions of Computing Disciplines

Computing Interrelationships

Emerging Curricula



Computing Interrelationships

- **Sistem/Teknik Komputer**: satu-satunya disiplin yang berfokus pada integrasi perangkat keras, perangkat lunak, dan pemrosesan sinyal yang penting di berbagai bidang seperti sistem cyber-fisik, komunikasi data, atau pencitraan medis
- **Ilmu Komputer**: memiliki fokus yang kuat dan spesifik pada pengembangan fondasi konseptual yang kuat dan kemampuan komputasi.
- **Cyber-Security**: mengeksplorasi pertanyaan tentang keselamatan, keamanan, dan kontinuitas di seluruh lanskap komputasi.
- **Sistem Informasi**: berfokus pada menemukan dan menerapkan perubahan organisasi yang positif menggunakan kemampuan komputasi dengan penekanan khusus pada nilai yang dihasilkan oleh informasi
- **Teknologi Informasi**: TI menekankan membangun dan memelihara kemampuan infrastruktur komputasi organisasi dan dukungan pengguna.
- **Rekayasa Perangkat Lunak**: SE membahas proses pengembangan perangkat lunak skala besar, terutama di area kritis keselamatan dan keamanan
- **Sains Data**: membahas manajemen, penyimpanan, dan pengambilan data skala besar yang didasarkan pada matematika dan statistik

Computing Interrelationships

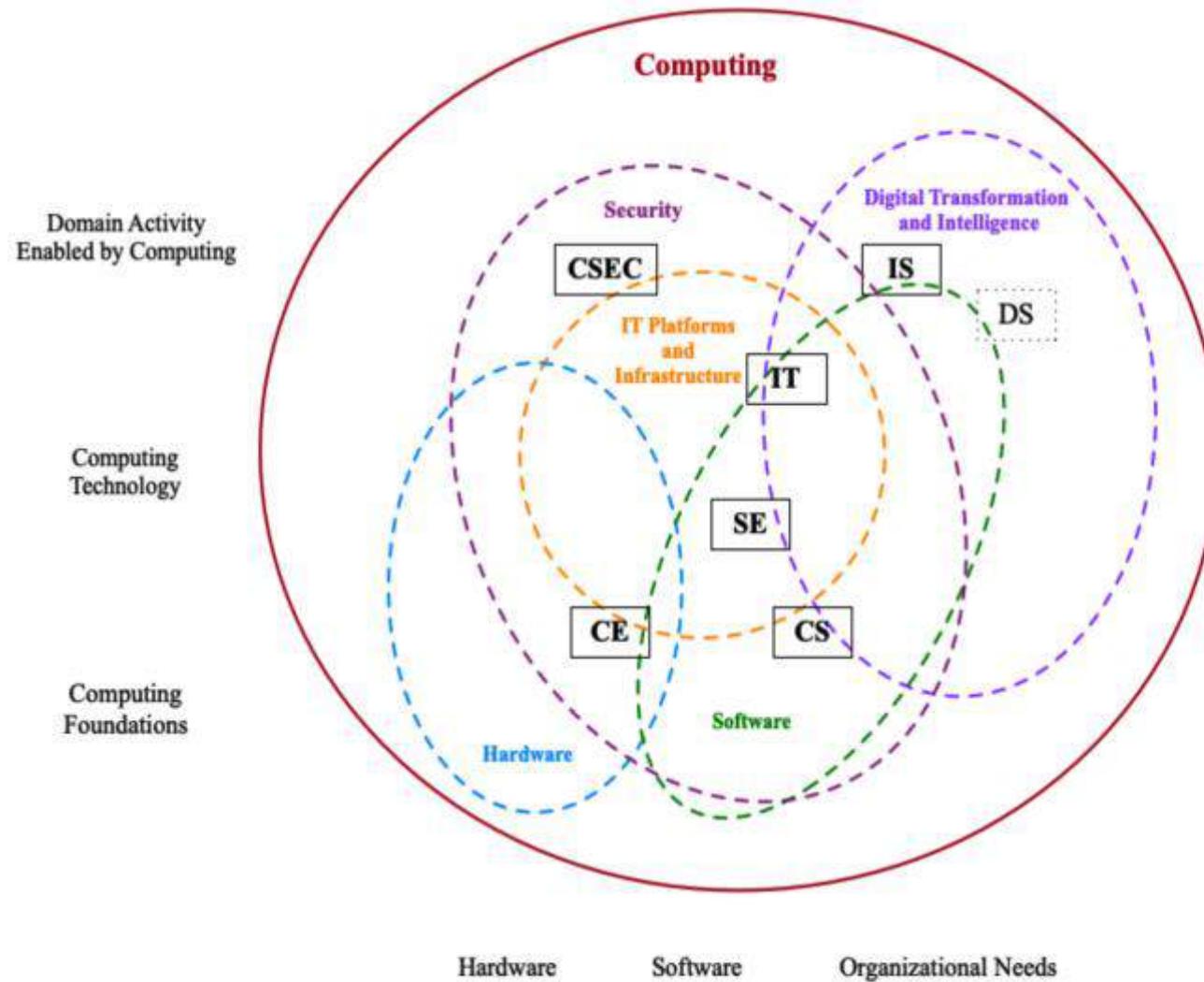


Figure 2.2. A contemporary view of the landscape of computing education

Legend: Curricular reports: CE=computer engineering; CS=computer science; CSEC=cybersecurity; IS=information systems; IT=information technology; SE=software engineering; DS=data science (under development).

Computing Interrelationships

Gambar 2.2 mengilustrasikan:

- tiga tingkat (**foundations**, **technology**, **domain activity**) dari “**computing**”
- terkait dengan perangkat keras, perangkat lunak, dan kebutuhan organisasi organizational

Daerah internal bertitik-titik karena tidak mutlak.

- **Information technology platforms and infrastructure** men-**capture** integrasi perangkat keras dan perangkat lunak ke dalam solusi teknologi yang memungkinkan solusi berbasis komputasi yang memiliki kemampuan terkait dengan penyimpanan data, pemrosesan, kecerdasan buatan, dan visualisasi.
 - Teknik komputer, ilmu komputer, dan rekayasa perangkat lunak menyediakan komponen yang diperlukan agar kemampuan teknologi komputasi ini ada.
 - Teknologi informasi berfokus pada membuat dan menjaganya tersedia untuk pengguna individu dan organisasi.
- **The area of digital intelligence and transformation** mencakup penangkapan (capture), pengelolaan, dan analisis data yang memungkinkan individu, organisasi, dan masyarakat untuk melakukan aktivitas mereka dengan cara membantu mencapai tujuan mereka dengan lebih baik.
 - Bidang sistem informasi (dan sains data) memungkinkan **digital intelligence and transformation**.
- **Security** diperlukan dan meresap/menembu seluruh ruang komputasi.
- Ini adalah proses di mana organisasi berubah menggunakan kemampuan komputasi.

Emerging Curricula

- Bidang “Curricula” saat ini yang muncul belakangan antara lain **cloud computing, smart cities, sustainability, parallel computing, internet of things, dan edge computing.**
- Selain itu, **sepuluh tren komputasi teratas** yang diprediksi muncul adalah
 - 1) deep learning (DL) and machine learning (ML),
 - 2) digital currencies,
 - 3) blockchain,
 - 4) industrial IoT,
 - 5) robotics,
 - 6) assisted transportation,
 - 7) assisted/augmented reality and virtual reality (AR/VR),
 - 8) ethics, laws, and policies for privacy, security, and liability,
 - 9) accelerators and 3D, and
 - 10) cybersecurity and AI

Model Kompetensi

Visi CC2020

Capaian Pembelajaran dan Competency

Model Kompetensi CC2020

Definsi-Definisi Komponen

Elemen-Elemen Komponen

Pembuatan Pernyataan Kompetensi



Visi CC2020

- Kurikulum harus dimodelkan sebagai kompetensi
 - Kompetensi memodelkan tujuan pembelajaran sebagai “produk perilaku”
 - Mengetahui “Apa” “Bagaimana” “Mengapa” (*Knowing “What” “How” “Why”*)
 - Pendidikan berbasis kompetensi mengilhami pemahaman praktik berbasis domain
 - Tujuan kurikulum adalah untuk mendefinisikan dan menanamkan kompetensi

Capaian Pembelajaran dan Kompetensi

■ Capaian Pembelajaran (CP)

- “berkaitan dengan pengetahuan, keterampilan, dan perilaku yang diperoleh para mahasiswa saat mereka berkembang melalui program” (ABET)

■ Kompetensi

- Apa yang seseorang dapat ***LAKUKAN*** stlh menyelesaikan kuliah (Baumgartner and Shankararaman. 2013)
- **Kerangka Lapisan Kompetensi:** Dalam konteks kompetensi, *disposisi* membantu mengatur pengetahuan dan keterampilan dalam konteks; untuk menghubungkan kemampuan (pengetahuan dan keterampilan) dengan tindak lanjut dari perilaku yang sesuai (Frezza et al., 2018)

Model Kompetensi CC2020

Kompetensi = [Pengetahuan + Ketrampilan + Disposisi] dalam Tugas

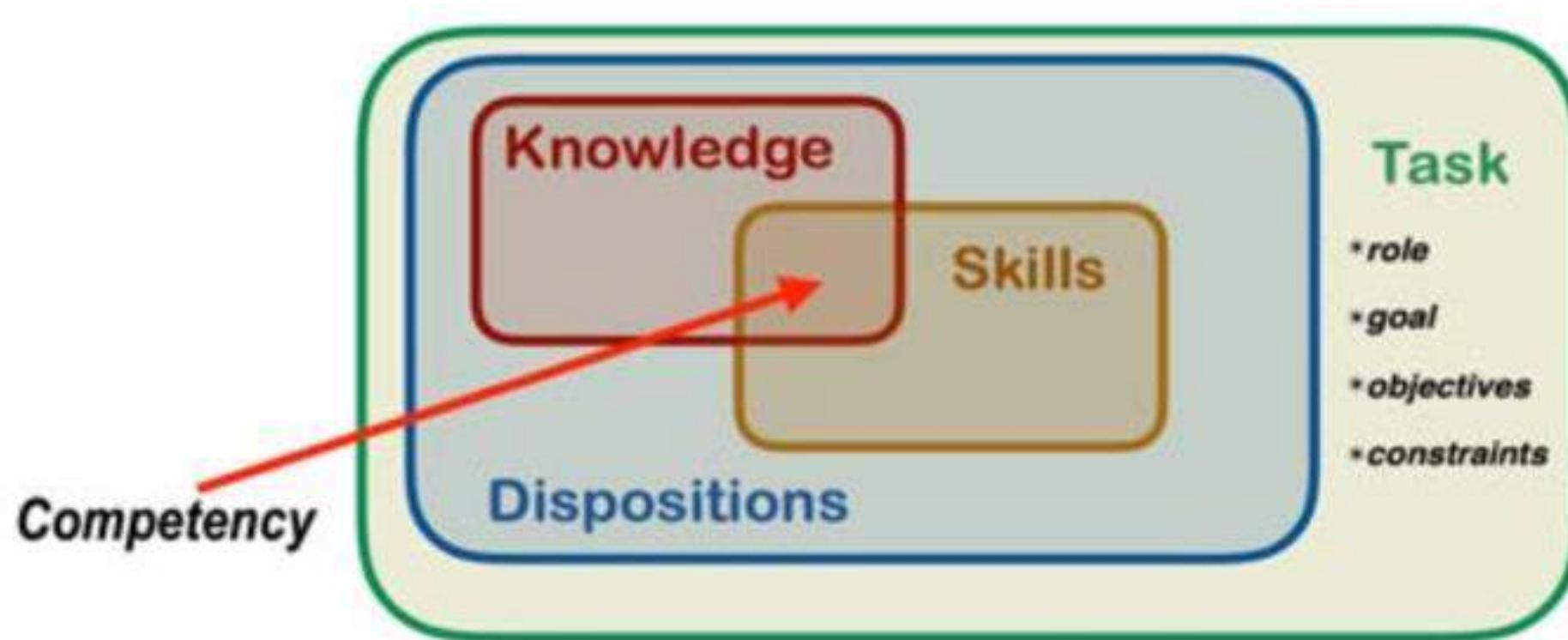


Figure 4.1. Conceptual Structure of the CC2020 Competency Model

Definisi-Definisi Komponen

Empat komponen (**pengetahuan**, **ketrampilan**, **disposisi**, dan **tugas**) yang menyusun spesifikasi kompetensi didefinisikan

1. **Pengetahuan** (fakta/gagasan yang memungkinkan kinerja yang memuaskan dari tugas-tugas yang relevan)
 - Pengetahuan adalah *dimensi kompetensi “know-what” sebagai pemahaman faktual*
2. **Ketrampilan** (tingkat penguasaan dalam menerapkan fakta/ide untuk mencapai hasil yang dihargai)
 - Keterampilan memperkenalkan kemampuan menerapkan pengetahuan untuk secara aktif menyelesaikan tugas.
 - Oleh karena itu, keterampilan mengungkapkan elemen pengetahuan yang ditindaklanjuti dengan kemahiran untuk mendefinisikan *dimensi kompetensi “know-how”*.
 - Keterampilan membutuhkan waktu dan latihan untuk berkembang.
 - Definisi kompetensi CC2020 telah mengadopsi tingkat proses kognitif Bloom untuk menentukan tingkat keterampilan yang diharapkan dalam penyelesaian tugas yang sukses.

Definisi-Definisi Komponen

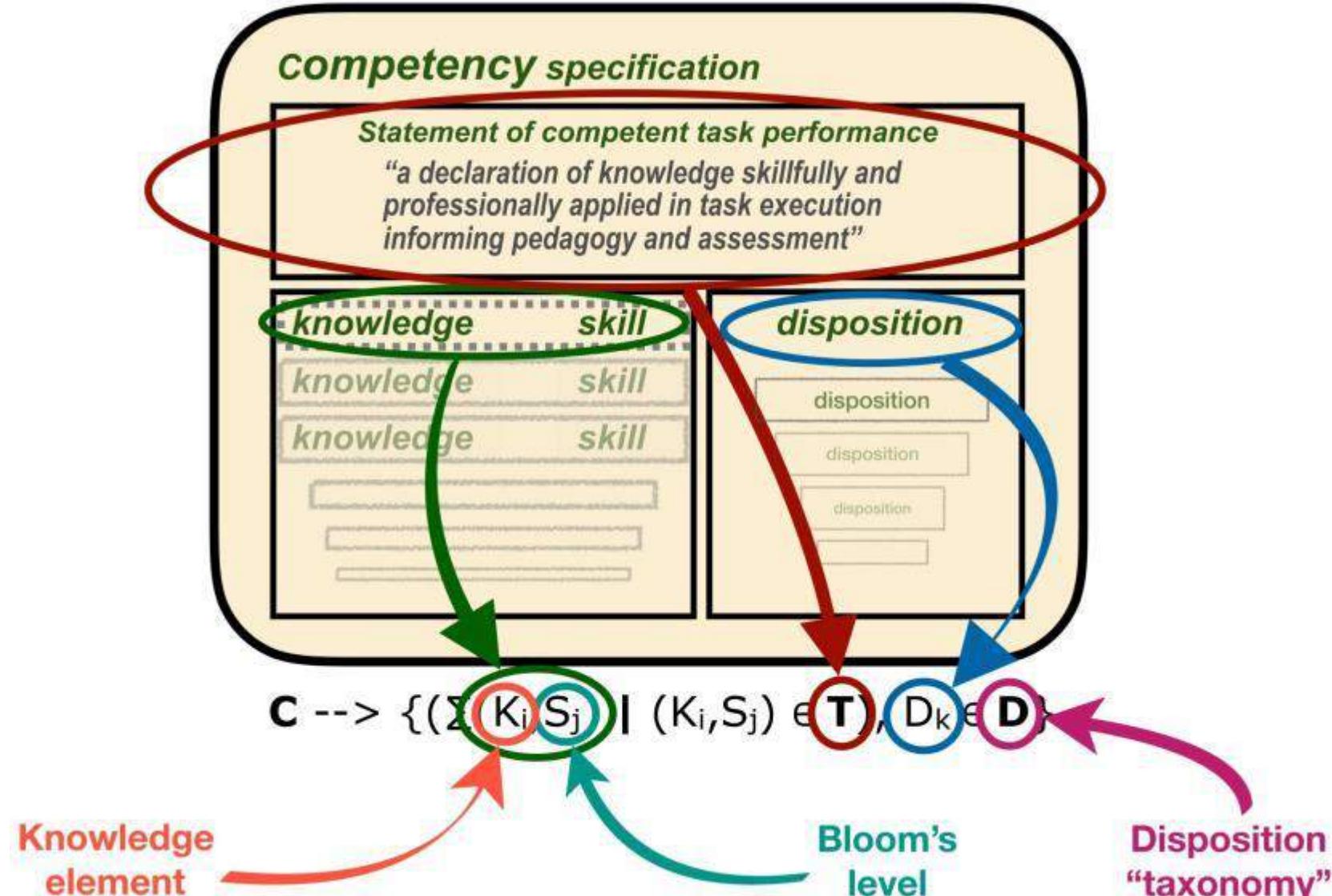
3. *Disposisi* (nilai dan motivasi yang memoderasi perilaku terampil untuk mempengaruhi kualitas kinerja profesional)

- *Disposisi* membungkai dimensi kompetensi “**know-why**” dan menentukan temperamen kualitas karakter dalam kinerja tugas.
- Disposisi memoderasi perilaku menerapkan “**know-what**” menjadi “**know-how**”.

4. *Tugas*

- *Tugas* adalah konstruksi yang membungkai penerapan pengetahuan yang terampil dan membuat disposisi menjadi konkret.
- Tugas yang diungkapkan sebagai pernyataan **prosa** sehari-hari menyediakan pengaturan untuk mewujudkan disposisi, di mana individu memoderasi pilihan, tindakan, dan upaya mereka yang diperlukan untuk mengejar dan berhasil dengan cara yang efisien dan efektif.
- Dalam pengertian ini, tugas mencakup konteks kompetensi yang bertujuan, memperlihatkan sifat integral dari pengetahuan, keterampilan, dan disposisi.

Competency = Knowledge + Skills + Dispositions



“Digitizing” Competency

T = task

$$T \rightarrow \{(K_i, S_j) \mid K_i \in K, S_j \in S\}$$

knowledge used at a level of skill

[Task: skillfully applied knowledge engaged in a purposeful act.]

D = disposition

[Disposition: aspect of commitment and motivation toward professional practice]

C = competency

$$C \rightarrow \{(\sum(K_i, S_j) \mid (K_i, S_j) \in T), D_k \in D\}$$

[Competency is a demonstrable capacity to skillfully apply knowledge that achieves a valued outcome in a situated task mediated by dispositions.]

E = education program

$$E \rightarrow \{C_i\}$$

[Educational Program: the cumulation of competencies that comprise it]

The challenge is establishing the language with which these T, K, D elements are described and then denoted in competency specifications and assessment.

B = baccalaureate degree

$$B_e \rightarrow \{\sum(C_i) \mid C_i \in E\}$$

[A baccalaureate is the cumulation of competencies comprising a course of learning.]

J = job description

$$J \rightarrow \{C_i\}$$

[Job Description: the cumulation of competencies defining that job's responsibilities]

P = profession

$$P \rightarrow \{J_i\}$$

[Profession: cumulation of job competencies that define it]

L = professional license

$$L_p \rightarrow \{\sum(J_i) \mid J_i \in P\}$$

[Professional License: the cumulation of assessed job competency that certifies a profession.]

Composing Competency-Based Curricula

“curriculum fragment”

C - (T, D)

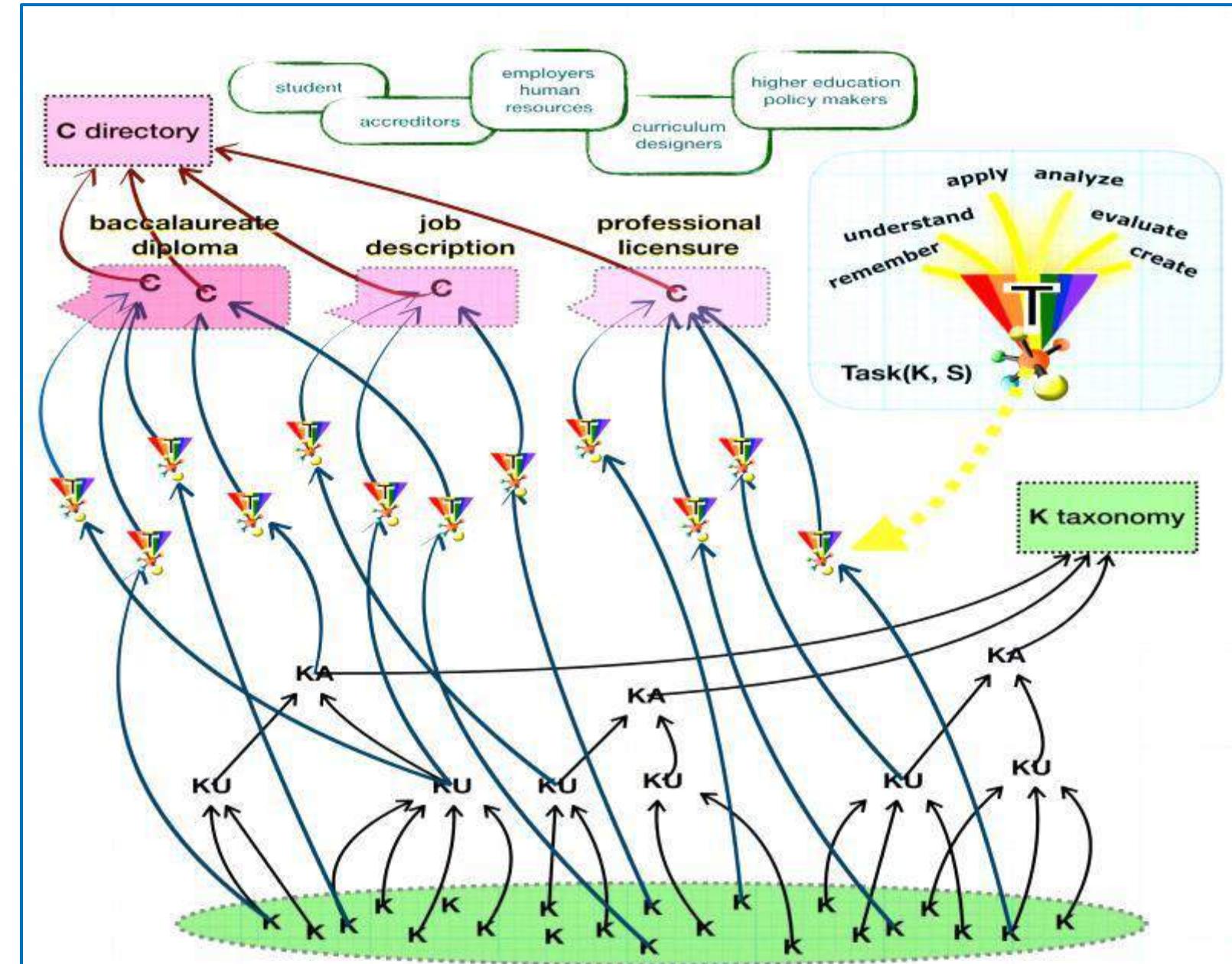
T - Task (K, S) ->

S - skill

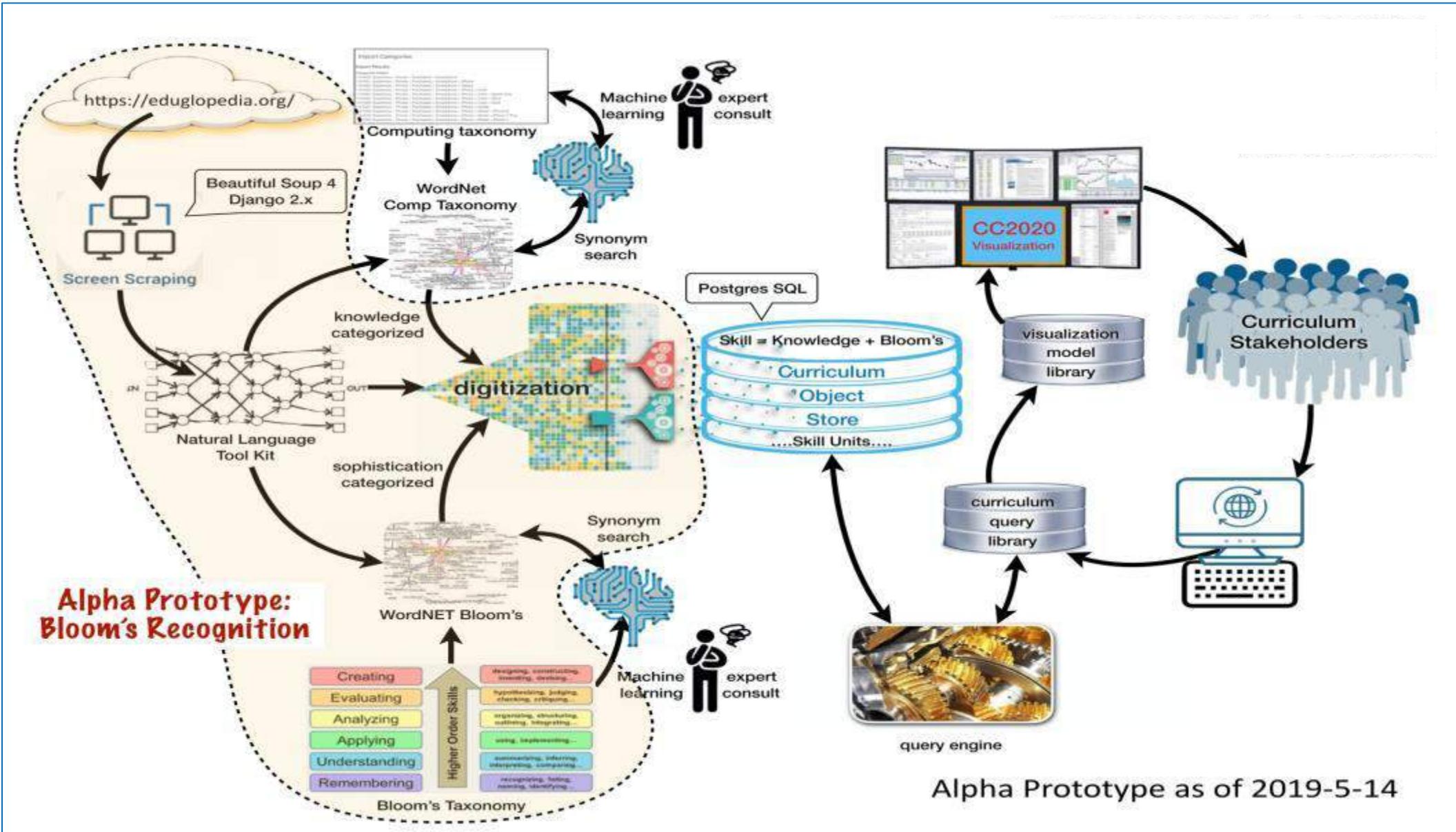
KU - unit / KA - area

K - knowledge element

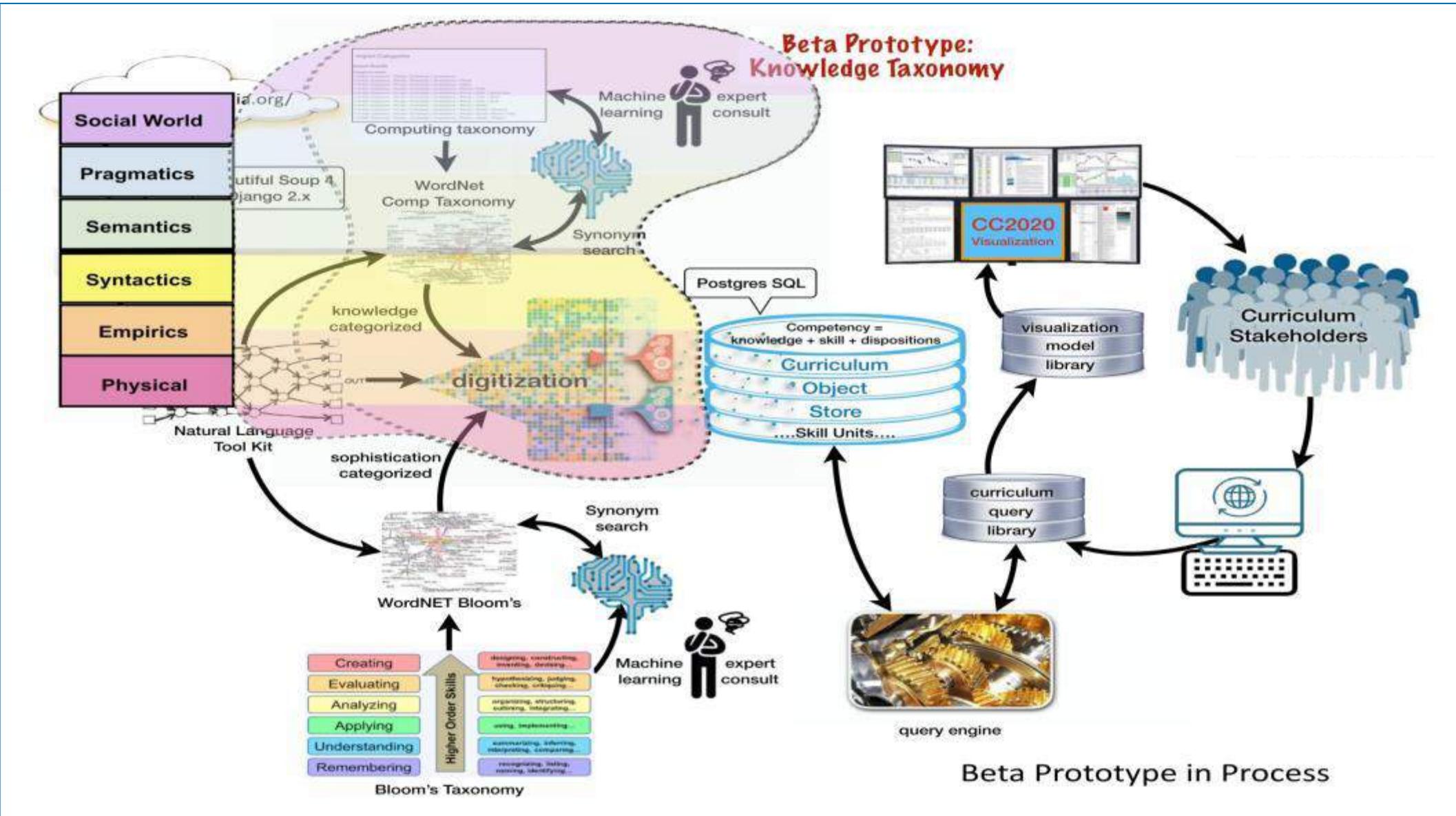
knowledge domain



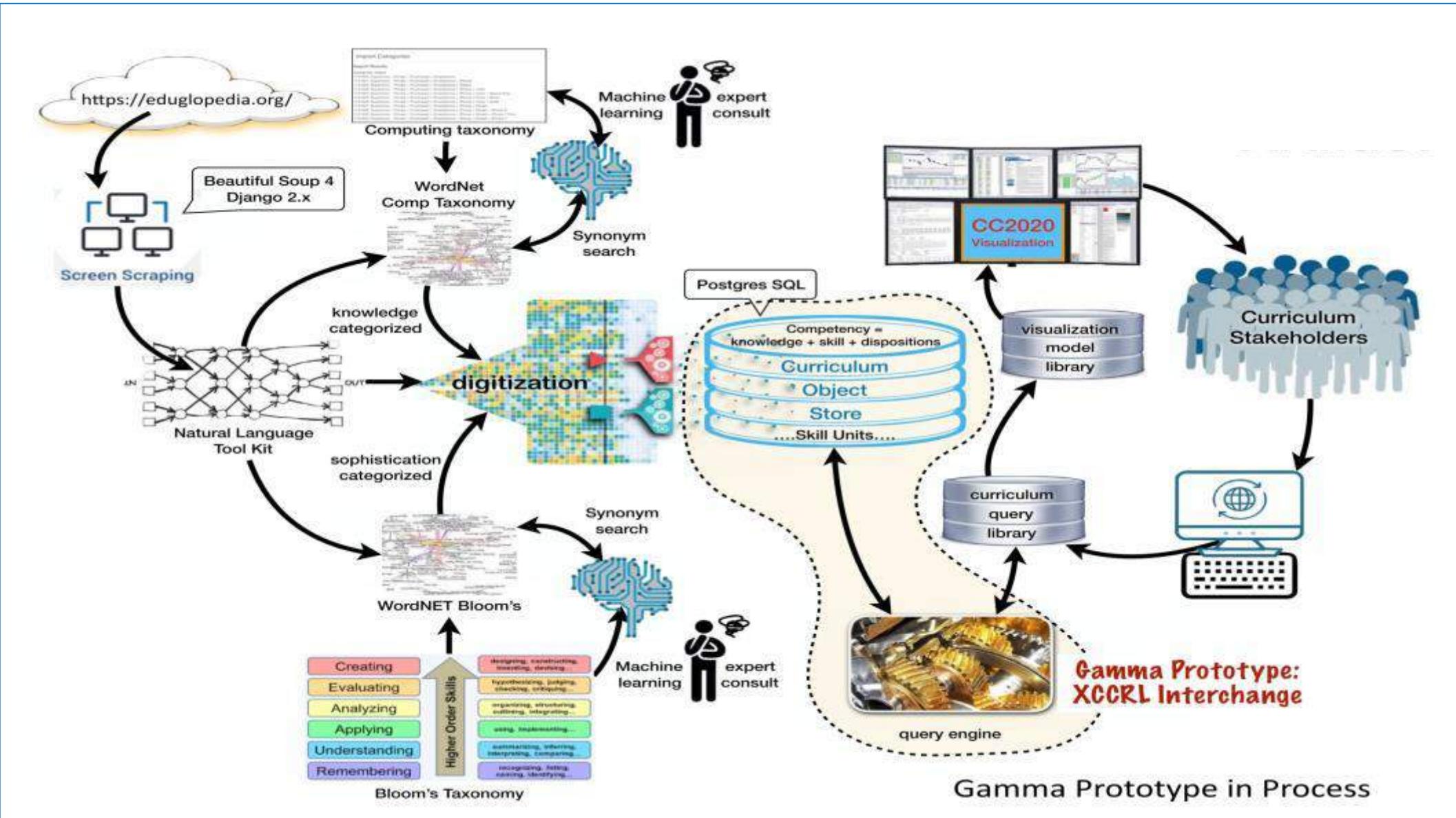
CC2020/EDSIG Tool Auxiliary Artifact



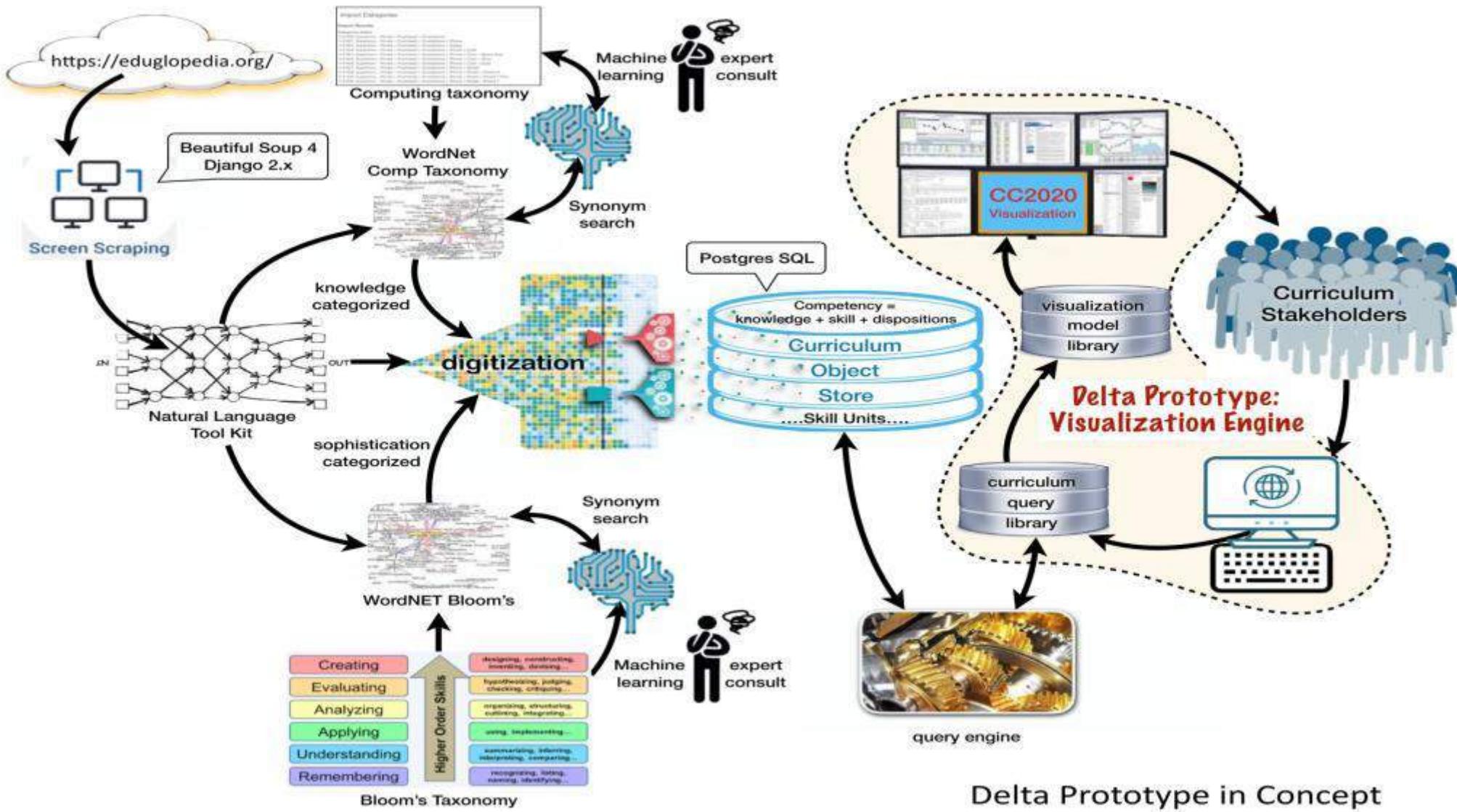
CC2020/EDSIG Tool Auxiliary Artifact



CC2020/EDSIG Tool Auxiliary Artifact



CC2020/EDSIG Tool Auxiliary Artifact



Bloom's (Revised) of Educational Objectives: Facets of Learning (Anderson, 2001)



Elemen-Elemen Komponen

- Kompetensi adalah kumpulan komponen spesifik dari pengetahuan, keterampilan, dan disposisi. Tabel 4.1, 4.2, 4.3, dan 4.4 menyajikan elemen yang disarankan dari dimensi ini.
- Dimensi pengetahuan kompetensi meliputi konsep yang bersifat teknis (konsep komputasi), dasar/pondasi dan profesional (indikasi tempat kerja), dan domain spesifik (pengaturan tugas).

Elemen-Elemen Komponen

Tabel 4.1 mengilustrasikan **tiga puluh empat** bidang pengetahuan yang disingkat yang dipartisi ke dalam urutan **enam kategori**.

Table 4.1. Elements of Computing Knowledge

Users and Organizations	Systems Modeling	Systems Architecture and Infrastructure	Software Development	Software Fundamentals	Hardware
Social Issues and Professional Practice Security Policy and Management IS Management and Leadership Enterprise Architecture Project Management User Experience Design	Security Issues and Principles Systems Analysis & Design Requirements Analysis and Specifications Data and Information Management	Virtual Systems and Services Intelligent Systems (AI) Internet of Things Parallel and Distributed Computing Computer Networks Embedded Systems Integrated Systems Technology Platform Technologies Security Technology and Implementation	Software Quality, Verification and Validation Software Process Software Modeling and Analysis Software Design Platform-Based Development	Graphics and Visualization Operating Systems Data Structures, Algorithms and Complexity Programming Languages Programming Fundamentals Computing Systems Fundamentals	Architecture and Organization Digital Design Circuits and Electronics Signal Processing

Elemen-Elemen Komponen

Tabel D.1 Ringkasan Representatif Area Pengetahuan Komputasi

Categorization	Computing Knowledge Area
1. Users and Organizations	K(C-1.1) Social Issues and Professional Practice
	K(C-1.2) Security Policy and Management
	K(C-1.3) IS Management and Leadership
	K(C-1.4) Enterprise Architecture
	K(C-1.5) Project Management
	K(C-1.6) User Experience Design
2. Systems Modeling	K(C-2.1) Security Issues and Principles
	K(C-2.2) Systems Analysis and Design
	K(C-2.3) Requirements Analysis and Specification
	K(C-2.4) Data and Information Management
3. Systems Architecture and Infrastructure	K(C-3.1) Virtual Systems and Services
	K(C-3.2) Intelligent Systems (AI)
	K(C-3.3) Internet of Things
	K(C-3.4) Parallel and Distributed Computing
	K(C-3.5) Computer Networks
	K(C-3.6) Embedded Systems
	K(C-3.7) Integrated Systems Technology
	K(C-3.8) Platform Technologies
	K(C-3.9) Security Technology and Implementation
4. Software Development	K(C-4.1) Software Quality, Verification and Validation
	K(C-4.2) Software Process
	K(C-4.3) Software Modeling and Analysis
	K(C-4.4) Software Design
	K(C-4.5) Platform-Based Development
5. Software Fundamentals	K(C-5.1) Graphics and Visualization
	K(C-5.2) Operating Systems
	K(C-5.3) Data Structures, Algorithms and Complexity
	K(C-5.4) Programming Languages
	K(C-5.5) Programming Fundamentals
	K(C-5.6) Computing Systems Fundamentals
6. Hardware	K(C-6.1) Architecture and Organization
	K(C-6.2) Digital Design
	K(C-6.3) Circuits and Electronics
	K(C-6.4) Signal Processing

Elemen-Elemen Komponen

Tiga belas elemen pengetahuan dasar dan profesional yang tercantum dalam Tabel 4.2 mewakili subset dari daftar profesional yang berasal dari laporan IT2017.

Table 4.2. Elements of Foundational and Professional Knowledge

Knowledge Elements	Meaning
Analytical and Critical Thinking	A mental process of simplifying complex information into basic parts and evaluating results to make proper decisions
Collaboration and Teamwork	Apportion challenging tasks into simpler ones and then work together to complete them efficiently
Ethical and Intercultural Perspectives	Ethical perspectives of the different viewpoints someone uses to view a problem in the context of individual human values
Mathematics and Statistics	Use of numbers and theories abstractly especially in the collection and analysis of numerical data
Multi-Task Prioritization and Management	Processing several issues or tasks at once while arranging them according to importance to do specific one first
Oral Communication and Presentation	Conveying a message orally using real-time presentations with visual aids related audience interests and goals
Problem Solving and Trouble Shooting	A logical and orderly search for the source of a unit problem and making the unit operational again
Project and Task Organization and Planning	A process to provide decisions about a project concerning organization and planning to achieve a successful result
Quality Assurance / Control	Use of techniques, methods, and processes to identify and prevent defects according to defined quality standards
Relationship Management	A strategy to maintain an ongoing level of engagement usually between a business and its customers or other businesses
Research and Self-Starter/Learner	Someone who begins or undertakes work or a project without needing direction or encouragement to do so
Time Management	An ability to use a person's time in an effective or productive manner to work efficiently
Written Communication	Use of a written form of interaction between people and organizations that provides an effective way of messaging

Elemen-Elemen Komponen

Tabel D.3 Contoh Area Pengetahuan Profesional dan Dasar

K(P-1)	Oral Communication & Presentation
K(P-2)	Written Communication
K(P-3)	Problem Solving and Trouble-Shooting
K(P-4)	Project and Task Organization and Planning
K(P-5)	Collaboration and Teamwork
K(P-6)	Research and Self-Starter/Learner
K(P-7)	Multi-Task Prioritization and Management
K(P-8)	Relationship Management
K(P-9)	Analytical and Critical Thinking
K(P-10)	Time Management
K(P-11)	Quality Assurance / Control
K(P-12)	Mathematics and Statistics
K(P-13)	Ethical and Intercultural Perspectives

Elemen-Elemen Komponen

Pengetahuan Domain Aplikasi

- Domain aplikasi yang umum untuk komputasi meliputi **business, medicine, engineering, transportation, entertainment**, dll.
- **Ada banyak subdisiplin**; beberapa adalah **Computing+X** dan lainnya adalah **X+ Computing** di mana posisi "X" menunjukkan apakah "X" adalah fokus disiplin utama, atau itu adalah domain aplikasi komputasi.
 - Misalnya, subdisiplin komputasi sistem informasi itu sendiri memiliki banyak turunan, program X-IS, (misalnya, accounting information systems, marketing-IS, finance-IS, medical-IS). Masing-masing program X-IS ini adalah disiplin tersendiri yang ditambah dengan komputasi.
- Setiap domain aplikasi yang digambarkan memerlukan rincian pengetahuan, keterampilan, dan mungkin, disposisi khusus yang berperan untuk membuat pilihan yang cerdas dan terinformasi yang dengan terampil menerapkan pengetahuan dalam desain dan keterlibatan artefak.

Elemen-Elemen Komponen

Sebagaimana CC2020 mendefinisikan keterampilan— penerapan pengetahuan yang mahir—Tabel 4.3 merangkum urutan **enam tingkat kumulatif ketrampilan (ketrampilan kognitif)** bersama dengan definisi singkatnya.

Level-level ini berkorelasi dengan **taksonomi Bloom** yang memungkinkan adopsi kosakata yang disepakati bersama seperti yang dijelaskan dalam revisi 2001 **pada taksonomi Bloom** tentang tujuan pendidikan. Tabel mencantumkan keterampilan kognitif sebagai kata kerja.

Table 4.3. Levels of Cognitive Skills Based on Bloom's Taxonomy

Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Exhibit memory of previously learned materials by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, and giving descriptions.	Solve problems in new situations by applying acquired knowledge, facts, techniques, and rules in a different way.	Examine and break information into parts by identifying motives or causes; make inferences and find evidence to support solutions.	Present and defend opinions by making judgments about information, validity of ideas, or quality of material.	Compile information together in a different way by combining elements in a new pattern or by proposing alternative solutions.

Elemen-Elemen Komponen

Disposition mendefinisikan **dimensi ketiga kompetensi**. Tabel 4.4 menampilkan **sebelas disposisi prospektif** yang diturunkan dari literatur.

Disposition, sebagai komponen intrinsik kompetensi, mewakili kesempatan untuk mengekspresikan nilai-nilai kelembagaan dan program yang diharapkan di tempat kerja.

Table 4.4. Prospective Elements of Dispositions

Element	Elaboration	Element	Elaboration
Adaptable	Flexible; agile, adjust in response to change	Professional:	Professionalism, discretion, ethical, astute
Collaborative:	Team player, willing to work with others	Purpose-driven:	Goal driven, achieve goals, business acumen
Inventive:	Exploratory. Look beyond simple solutions	Responsible:	Use judgment, discretion, act appropriately
Meticulous:	Attentive to detail; thoroughness, accurate	Responsive:	Respectful; react quickly and positively
Passionate:	Conviction, strong commitment, compelling	Self-directed:	Self-motivated, determination, independent
Proactive:	With initiative, self-starter, independent		

Pembuatan Pernyataan Kompetensi

Model kompetensi yang diadopsi dalam Laporan CC2020 ini menunjukkan bahwa pernyataan seputar kompetensi mencakup elemen pengetahuan yang dipasangkan dengan tingkat ketrampilan dan dengan disposisi.

Contoh berikut menunjukkan cara untuk melakukan ini. Masing-masing dari tiga contoh kompetensi berikut menentukan pernyataan tugas yang harus dilakukan dan merinci komponen yang dianggap relevan untuk menyelesaikan tugas itu secara efektif dan efisien.

Pembuatan Pernyataan Kompetensi

Example A: From Computer Engineering

Competency Title: A	
Competency Statement	
	Manage the design of a computer system for a manufacturer using appropriate tools, design digital circuits including the basic building blocks of Boolean algebra, computer numbering systems, data encoding, combinatorial and sequential elements.
Knowledge Element [Table #]	Skill Level [Table 4.3]
Architecture and Organization [4.1]	Creating
Digital Design [4.1]	Creating
Circuits/Electronics [4.1]	Creating
Analytical and Critical Thinking [4.2]	Applying
Mathematics and Statistics [4.2]	Applying
Problem Solving and Trouble Shooting [4.2]	Applying
Research and Self-Starter/Learner [4.2]	Applying
Disposition(s) [Table 4.4]	
Self-directed	Meticulous
	Inventive

Pembuatan Pernyataan Kompetensi

Example B: From Information Technology

Competency Title: B	
Competency Statement	
Analyze and compare several networking topologies in terms of robustness, expandability, and throughput used within a cloud enterprise.	
Knowledge Element [Table #]	Skill Level [Table 4.3]
Computer Networks [4.1]	Analyzing
Platform Technologies [4.1]	Analyzing
Analytical and Critical Thinking [4.2]	Applying
Mathematics and Statistics [4.2]	Applying
Quality Assurance [4.2]	Applying
Disposition(s) [Table 4.4]	
Self-directed	Purpose-driven
	Responsible

Pembuatan Pernyataan Kompetensi

Example C: From Software Engineering

Competency Title: C	
Competency Statement	
Identify and document system requirements by applying a known requirements elicitation technique in work sessions with stakeholders, using facilitative skills, as a contributing member of a requirements team.	
Knowledge Element [Table #]	Skill Level [Table 4.3]
Requirements Analysis [4.1]	Evaluating
Oral Communication [4.2]	Applying
Written Communication [4.2]	Applying
Teamwork and Collaboration [4.2]	Applying
Disposition(s) [Table 4.4]	
Purpose-driven	Responsible
	Collaborative

Analysis and Visualization of Curricula

Visualization of the Landscape of Computing Knowledge Table



Visualization of the Landscape of Computing Knowledge Table

Table 5.3 Landscape of Computing Knowledge

		CE		CS		CSEC		IS		IT		SE	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1. Users and Organizations	1.1. Social Issues and Professional Practice	2	5	2	4	2	4	3	5	2	4	3	5
	1.2. Security Policy and Management	1	3	2	3	4	5	2	3	2	4	2	4
	1.3. IS Management and Leadership	0	2	0	2	1	2	4	5	1	2	1	2
	1.4. Enterprise Architecture	0	1	0	1	1	2	3	5	1	3	1	3
	1.5. Project Management	1	3	2	3	1	2	4	5	2	3	2	4
	1.6. User Experience Design	1	3	2	4	1	3	2	4	3	4	3	5
2. Systems Modeling	2.1. Security Issues and Principles	2	3	2	3	4	5	2	4	3	4	2	4
	2.2. Systems Analysis & Design	1	2	1	2	1	2	4	5	1	3	2	4
	2.3. Requirements Analysis and Specification	1	2	1	2	0	2	2	4	1	3	3	5
	2.4. Data and Information Management	1	2	2	4	2	3	3	5	2	3	2	4
3. Systems Architecture and Infrastructure	3.1. Virtual Systems and Services	1	3	1	3	1	2	1	2	3	4	1	3
	3.2. Intelligent Systems (AI)	1	3	3	5	1	2	1	2	1	2	0	1
	3.3. Internet of Things	2	4	0	2	1	3	1	3	2	4	1	3
	3.4. Parallel and Distributed Computing	2	4	2	4	1	2	1	3	1	3	2	3
	3.5. Computer Networks	2	4	2	4	2	4	1	3	3	4	2	2
	3.6. Embedded Systems	3	5	0	2	1	3	0	1	0	1	0	3
	3.7. Integrated Systems Technology	1	2	0	2	0	2	1	3	3	4	1	3
	3.8. Platform Technologies	0	1	1	2	1	2	1	3	2	4	0	2
	3.9. Security Technology and Implementation	2	3	2	4	4	5	1	3	2	4	2	4

Visualization of the Landscape of Computing Knowledge Table

4. Software Development	4.1. Software Quality, Verification and Validation	1	3	1	3	1	2	1	3	1	2	3	5
	4.2. Software Process	1	2	1	3	0	2	1	3	1	3	3	5
	4.3. Software Modeling and Analysis	1	3	1	3	1	2	2	4	1	3	4	5
	4.4. Software Design	2	4	2	4	1	3	1	3	1	2	4	5
	4.5. Platform-Based Development	0	2	2	4	0	1	1	3	2	4	1	3
5. Software Fundamentals	5.1. Graphics and Visualization	1	2	2	4	0	1	1	1	0	1	0	2
	5.2. Operating Systems	2	4	3	5	2	3	1	2	1	3	1	3
	5.3. Data Structures, Algorithms and Complexity	2	4	4	5	1	3	1	3	1	2	2	4
	5.4. Programming Languages	2	3	3	5	1	2	1	2	1	2	2	3
	5.5. Programming Fundamentals	2	4	4	5	2	3	1	3	2	4	3	5
	5.6. Computing Systems Fundamentals	2	3	2	3	1	2	2	3	1	3	2	3
6. Hardware	6.1. Architecture and Organization	4	5	3	4	1	3	1	2	1	2	1	3
	6.2. Digital Design	4	5	1	2	0	2	0	1	0	1	0	2
	6.3. Circuits and Electronics	4	5	1	2	0	1	0	1	1	2	0	1
	6.4. Signal Processing	3	4	0	1	0	2	0	1	0	1	0	1

Visualization of the Landscape of Computing Knowledge Table

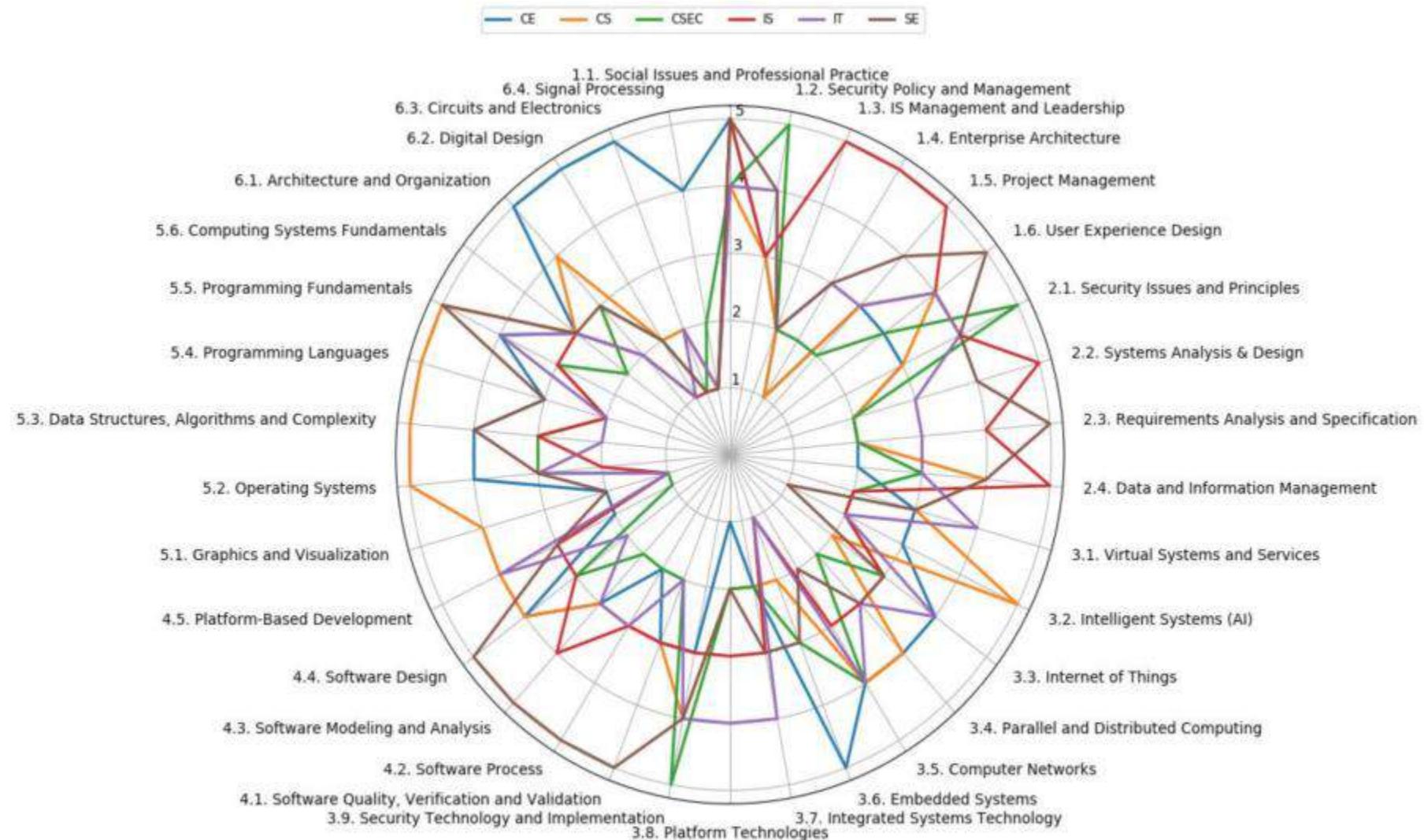


Figure 5.10. Radar Chart showing maximum emphasis of knowledge areas

CC2020 Max Emphasis

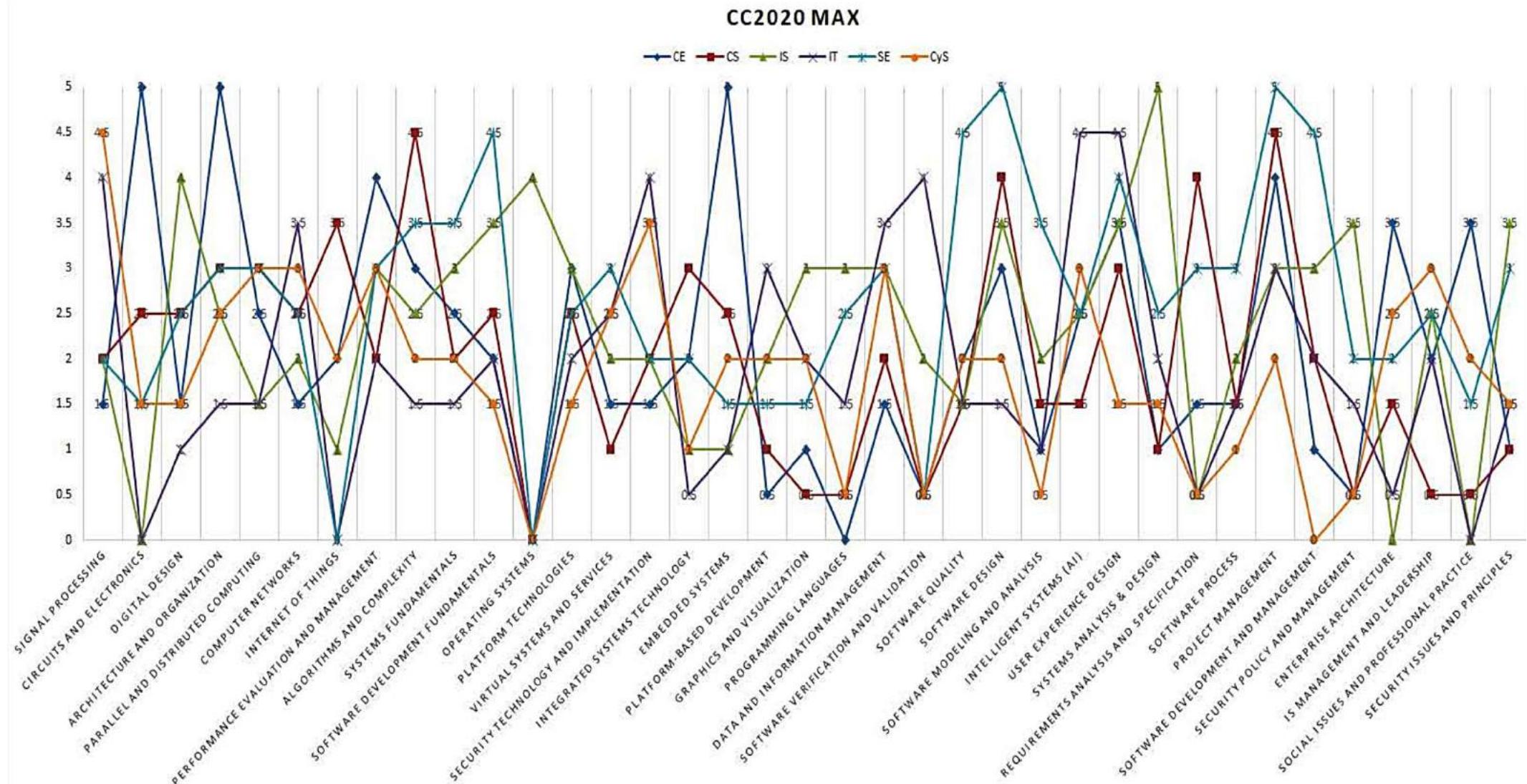


Figure G.19. Line Chart showing maximum emphasis of knowledge areas

CC2020 Max Emphasis

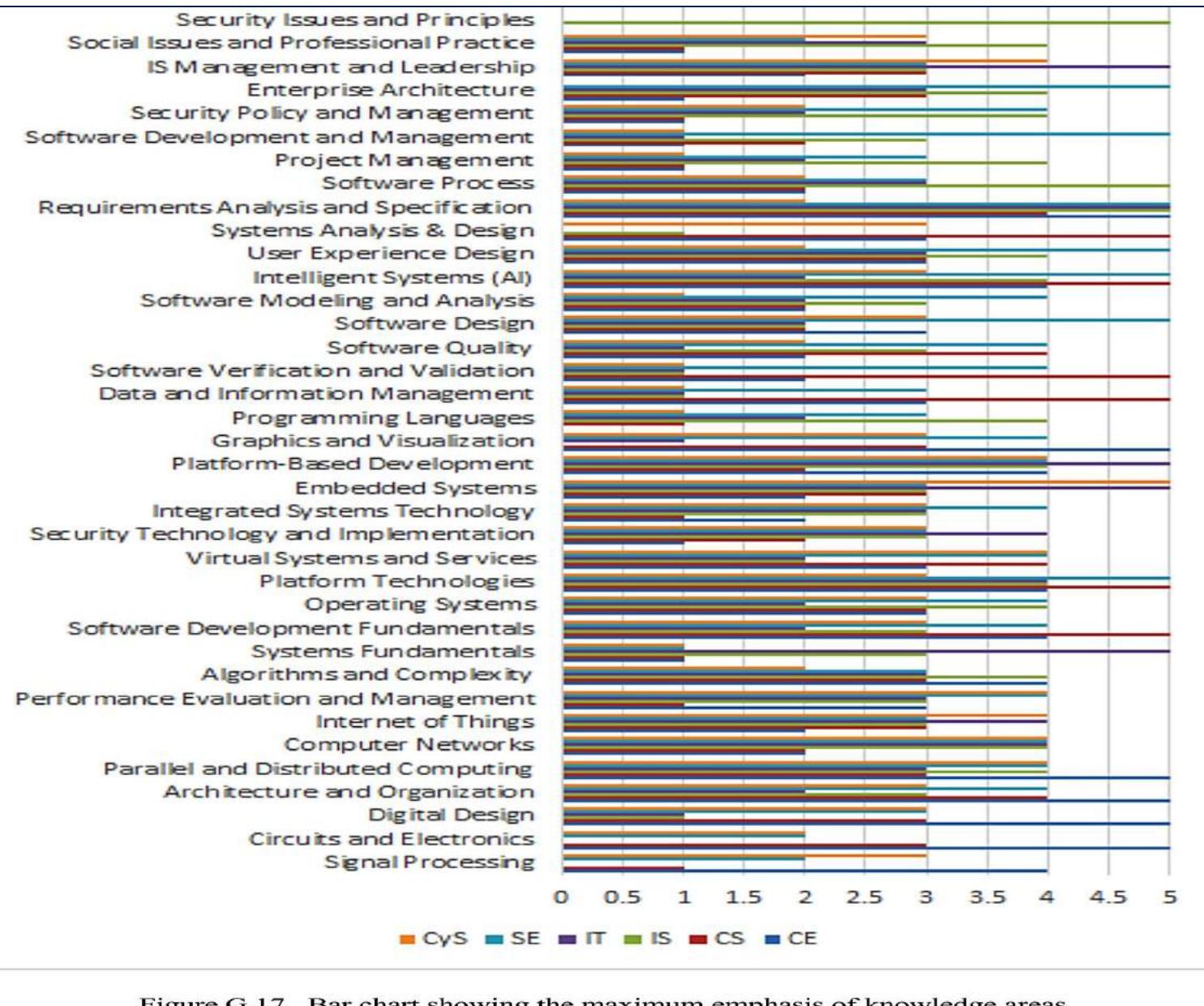


Figure G.17. Bar chart showing the maximum emphasis of knowledge areas

Table 3.1 provides a comparative view of the emphasis on computing topics among the five kinds of degree programs covered. The left column contains a **list of 40 topics** that represent areas of computing knowledge and skill that students study in computing degree programs.

Table 3.1: Comparative weight of computing topics across the five kinds of degree programs

Knowledge Area	CE		CS		IS		IT		SE	
	min	max								
Programming Fundamentals	4	4	4	5	2	4	2	4	5	5
Integrative Programming	0	2	1	3	2	4	3	5	1	3
Algorithms and Complexity	2	4	4	5	1	2	1	2	3	4
Computer Architecture and Organization	5	5	2	4	1	2	1	2	2	4
Operating Systems Principles & Design	2	5	3	5	1	1	1	2	3	4
Operating Systems Configuration & Use	2	3	2	4	2	3	3	5	2	4
Net Centric Principles and Design	1	3	2	4	1	3	3	4	2	4
Net Centric Use and configuration	1	2	2	3	2	4	4	5	2	3
Platform technologies	0	1	0	2	1	3	2	4	0	3
Theory of Programming Languages	1	2	3	5	0	1	0	1	2	4
Human-Computer Interaction	2	5	2	4	2	5	4	5	3	5
Graphics and Visualization	1	3	1	5	1	1	0	1	1	3
Intelligent Systems (AI)	1	3	2	5	1	1	0	0	0	0
Information Management (DB) Theory	1	3	2	5	1	3	1	1	2	5
Information Management (DB) Practice	1	2	1	4	4	5	3	4	1	4
Scientific computing (Numerical mthds)	0	2	0	5	0	0	0	0	0	0
Legal / Professional / Ethics / Society	2	5	2	4	2	5	2	4	2	5
Information Systems Development	0	2	0	2	5	5	1	3	2	4
Analysis of Business Requirements	0	1	0	1	5	5	1	2	1	3
E-business	0	0	0	0	4	5	1	2	0	3
Analysis of Technical Requirements	2	5	2	4	2	4	3	5	3	5
Engineering Foundations for SW	1	2	1	2	1	1	0	0	2	5
Engineering Economics for SW	1	3	0	1	1	2	0	1	2	3
Software Modeling and Analysis	1	3	2	3	3	3	1	3	4	5
Software Design	2	4	3	5	1	3	1	2	5	5
Software Verification and Validation	1	3	1	2	1	2	1	2	4	5
Software Evolution (maintenance)	1	3	1	1	1	2	1	2	2	4
Software Process	1	1	1	2	1	2	1	1	2	5
Software Quality	1	2	1	2	1	2	1	2	2	4
Comp Systems Engineering	5	5	1	2	0	0	0	0	2	3
Digital logic	5	5	2	3	1	1	1	1	0	3
Embedded Systems	2	5	0	3	0	0	0	1	0	4
Distributed Systems	3	5	1	3	2	4	1	3	2	4
Security: issues and principles	2	3	1	4	2	3	1	3	1	3
Security: implementation and mgt	1	2	1	3	1	3	3	5	1	3
Systems administration	1	2	1	1	1	3	3	5	1	2
Management of Info Systems Org.	0	0	0	0	3	5	0	0	0	0
Systems integration	1	4	1	2	1	4	4	5	1	4
Digital media development	0	2	0	1	1	2	3	5	0	1
Technical support	0	1	0	1	1	3	5	5	0	1

Table 3.2 provides a similar view concerning the relative emphasis on 17 non-computing topics across the five kinds of computing degrees.

Table 3.2: Comparative weight of non-computing topics across the five kinds of degree programs

Knowledge Area	CE		CS		IS		IT		SE	
	<i>min</i>	<i>max</i>								
Organizational Theory	0	0	0	0	1	4	1	2	0	0
Decision Theory	0	0	0	0	3	3	0	1	0	0
Organizational Behavior	0	0	0	0	3	5	1	2	0	0
Organizational Change Management	0	0	0	0	2	2	1	2	0	0
General Systems Theory	0	0	0	0	2	2	1	2	0	0
Risk Management (Project, safety risk)	2	4	1	1	2	3	1	4	2	4
Project Management	2	4	1	2	3	5	2	3	4	5
Business Models	0	0	0	0	4	5	0	0	0	0
Functional Business Areas	0	0	0	0	4	5	0	0	0	0
Evaluation of Business Performance	0	0	0	0	4	5	0	0	0	0
Circuits and Systems	5	5	0	2	0	0	0	1	0	0
Electronics	5	5	0	0	0	0	0	1	0	0
Digital Signal Processing	3	5	0	2	0	0	0	0	0	2
VLSI design	2	5	0	1	0	0	0	0	0	1
HW testing and fault tolerance	3	5	0	0	0	0	0	2	0	0
Mathematical foundations	4	5	4	5	2	4	2	4	3	5
Interpersonal communication	3	4	1	4	3	5	3	4	3	4

Maximum Emphasis Comparison

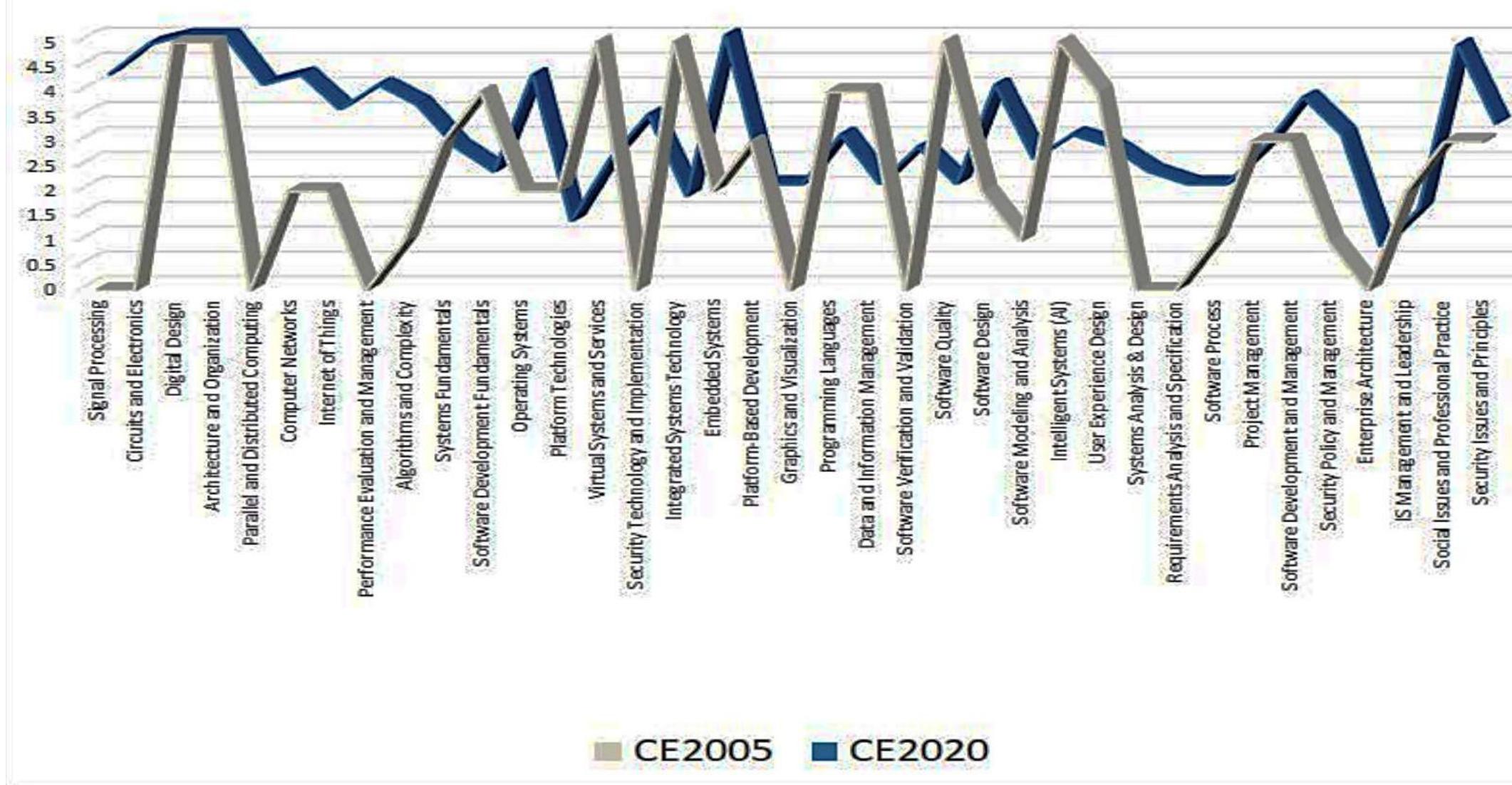


Figure G.20. Ribbon Chart comparing the maximum emphasis of knowledge areas between CE2005 and CE2020

Maximum Emphasis Comparison

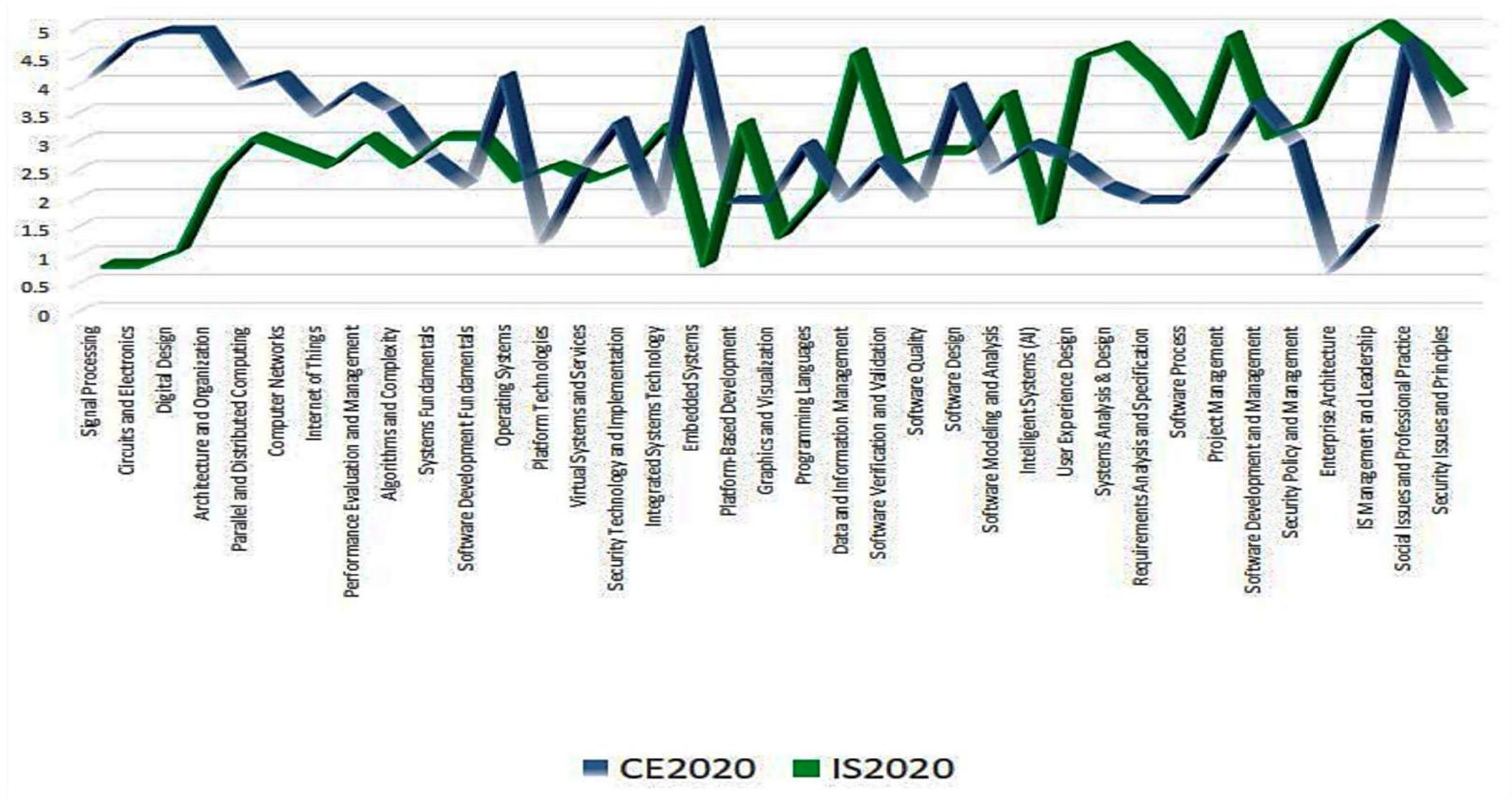


Figure G.21. Ribbon Chart comparing the maximum emphasis of knowledge areas between CE2020 and IS2020

Competency-Based Model In IS2020 Curricula



Pendahuluan IS2020: Displin SI, Profil SI

IS2020 Pembaruan Model Kurikulum

IS2020 Introduction

The IS Discipline

- 2020,
 - Citing the Computing Curricula 2020 report, the IS discipline focuses “... *on information (i.e. data in a specific context)* *together with information capturing, storage, processing and analysis/interpretation in ways that supports decision*” and “*deals with building information processing into organizational procedures and systems that enable processes as permanent, ongoing capabilities.*”

The IS Discipline

- Definisi awal Sistem Informasi mengartikulasikan **lima komponen utama, perangkat keras, perangkat lunak, data, pengguna, dan proses** (atau **prosedur**), definisi yang lebih baru mencakup **elemen keenam** untuk menjelaskan **media/komunikasi**.
- Selain itu, transisi penggunaan kata "**People**" juga menggantikan istilah "**User**", yang menunjukkan sifat "ada dimana-mana" (**ubiquitous nature**) dari sistem informasi di masyarakat kita.



Figure 1-2 Elements of an Information System (Bélanger, Van Slyke and Crossler 2019)

The IS Profession

- Pedoman kurikulum SI sebelumnya juga memberikan beberapa petunjuk untuk mengidentifikasi profesi SI. Untuk tujuan itu, laporan pedoman kurikulum sebelumnya telah mengidentifikasi beberapa jabatan sebagai perwakilan dari profesi IS (Tabel 1-2).

Table 1- 2 Profiles discussed in IS2010 and MSIS 2016

IS 2010 (Undergraduate)	MSIS 2016 (Graduate)
Application Developer	IT Consultant/Systems Analyst
Business Analyst	Project Manager
Business Process Analyst	Analytics Specialist
Database Administrator	Start-Up Entrepreneur

- IS 2010** menyediakan profil dari banyak pekerjaan, tetapi memilih untuk menekankan **application developer**, **business analyst**, **business process analyst**, dan **database administrator** sebagai yang paling representatif untuk profesi SI.
- Demikian pula, **MSIS 2016** menyediakan profil bagi lulusan program S2 SI di empat bidang berikut - **IT consultant**, **project manager**, **analytics specialist**, and **start-up entrepreneur**.
- Mengikuti tradisi ini di **IS 2020**, kita menyediakan ilustrasi lebih lanjut tentang persyaratan kompetensi dalam profil pekerjaan IS yang khas (**IT Consultant**, **Data Analyst**, **Software Application Developer**, **Computer Systems Analyst**, **IT Auditor**) pada Lampiran A, dengan daftar rinci dan deskripsi persyaratan kompetensi di setiap profil.

The IS Profession

- Sumber tambahan dan konkret yang tersedia untuk mendefinisikan “**Profesi SI**” adalah penempatan kerja lulusan IS (Tabel 1-3).

Table 1-3 Most Common IS Occupations Obtained by Recent Grads (AIS Job Index)

Rank	AIS Job Index 2017	AIS Job Index 2019
1	IT Consultant	IT Consultant
2	Data Analytics	Data Analytics (Data Analyst)
3	Computer Systems Analyst	Computer Systems Analyst
4	Software Application Developer	IT Auditor
5	IT Auditor	Software Applications Developer
6	Project Manager	Information Security Analyst

- Association for Information Systems (AIS) menerbitkan Indeks Pekerjaan dua tahunan dengan rincian penempatan kerja untuk lulusan SI baru-baru ini.
 - In the **2019** AIS Job Index Survey, 1,420 recent IS graduates responded from 43 different US universities.
 - The results indicate which jobs are most held and obtained by IS graduates. The most recent AIS Job Index indicates that the most common job title of IS graduates was **IT consultant**, Data analytics, computer systems analyst, IT auditor and software application developer round out the top six.
 - To wit, given the results of the latest AIS Job Index, it can be concluded that the **computing security** should be added or incorporated into the required (core) competencies of the discipline.

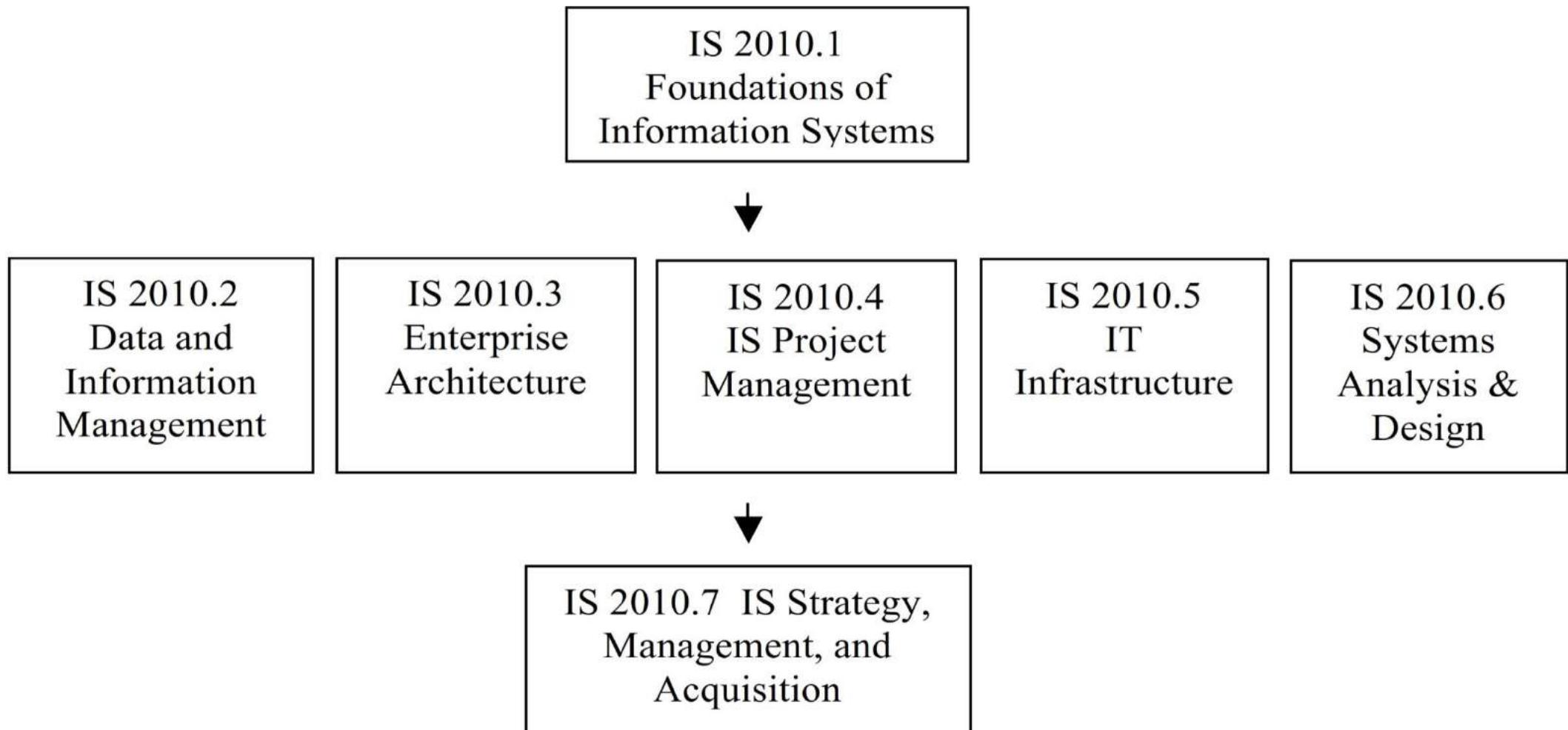
IS2020 Pembaruan Model Kurikulum

Pendekatan **Sebelumnya**

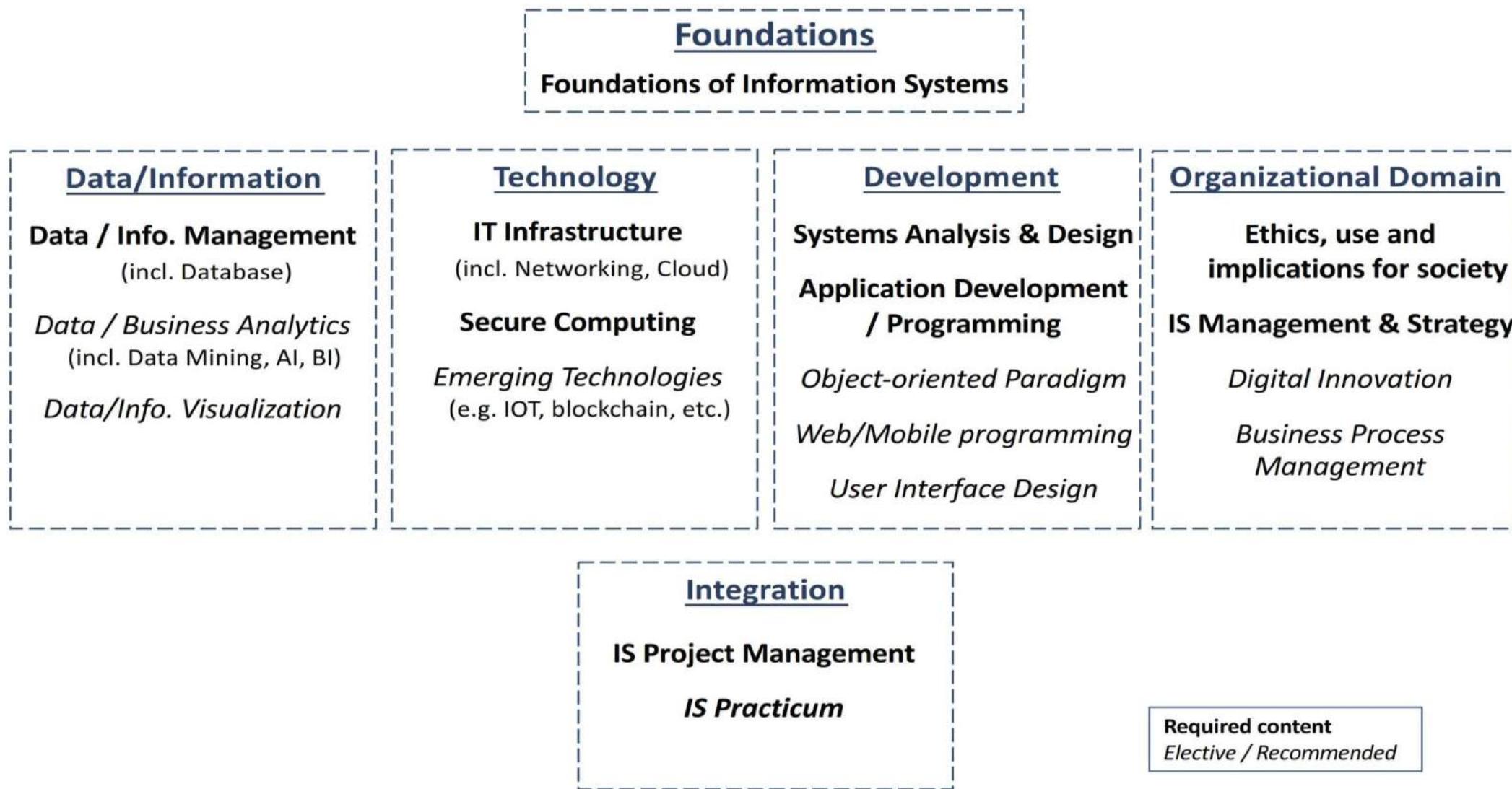
- Kurikulum SI (**IS 2002**, **IS 2010**, dan **MSIS 2016**) telah direpresentasikan terutama melalui kuliah: Inti dan Pilihan
 - Untuk setiap kuliah, telah ditetapkan tujuan dan topik pembelajaran.
- Penekanan pada pandangan khusus kuliah
 - **IS 2010**: Kemampuan lulusan tingkat program ditetapkan pada tingkat abstraksi yang tinggi, tetapi tidak ada pemetaan ke tingkat kursus

IS 2010 ACM/AIS Curriculum Guidelines For Information Systems

IS 2010 Core Courses



IS Competencies: Competency Based IS2020 ACM/AIS Curriculum Guidelines For Information Systems



Changes in the IS program core

- While IS2010 defined the core of IS under-graduate programs via **seven core courses** (Table 2-1, column to the left), IS2020 identifies 10 required competency areas (Table 2-1, column to the right). Six out of seven core courses appear as a required competency area in IS2020

Table 2-1 Core courses in IS2010 and their inclusion in the IS2020 required competency areas

IS2010 core courses	IS2020 required competency areas
1. Foundations of Information Systems	1. Foundations of Information Systems
2. Data and Information Management	2. Data / Info. Management
3. IT Infrastructure	3. IT Infrastructure
4. IS Project Management	4. IS Project Management
5. Systems Analysis and Design	5. Systems Analysis & Design
6. IS Strategy, Management, and Acquisition	6. IS Management & Strategy
7. Enterprise Architecture	(not included as a competency area)

- As another major change, IS2020 proposes four new IS competency areas to be included in core IS undergraduate curriculum requirements (Table 2-2). Two of the changes (Application Development and Secure Computing) move what previously accommodated as material for an elective course to the required competencies for IS graduates. Two of the new competency areas are completely new in the sense that they did not appear as separate courses in the IS2010 report. The following sections briefly explain the arguments for including these competency areas in the IS undergraduate curriculum core

Table 2-2 Introduction of new IS competency areas in the IS2020

IS2010 (elective) courses	IS2020 required competency areas
(Elective: Application development)	Application development / programming
(Elective: IT security and risk management) (Elective: IT audit and Controls)	Secure computing
(none)	Ethics, use and implications for society
(none)	Practicum

IS Competency Realms

Table 2-3 IS Competency realms guiding program profiling and specialization

IS competency realm	Required competency areas in IS2020	Elective competency areas in IS2020	Courses mentioned in IS2010 (Figure 6)
Foundations	Foundations of Information Systems		
Data and Information Management	Data / Info. Management	Data / Business Analytics (incl. Data Mining, AI, BI) Data / Info Visualization	Data mining / business intelligence Info. search and retrieval Knowledge management
Technology and Security	IT Infrastructure Secure computing	Emerging technologies (e.g., IOT, blockchain)	IT audit and controls IT security and risk management
Development	Systems analysis & design Application Development & Programming	Object oriented paradigm Web development Mobile development User interface design	Application development Collaborative Computing Human-Computer Interaction
Organizational Domain	Ethics, use and implications for society IS management and strategy	Digital Innovation Business Process Management	Business Process Management Enterprise systems Social Informatics
Integration	IS Project Management IS Practicum		

Profesi/Profil Lulusan dari Skill Framework in Information Age (SFIA) dan IS2020 Model Kompetensi untuk Program Sarjana Sistem Informasi

Profesi/Profil Lulusan	Kompetensi Inti (Core) / (Yang Diperlukan)										Kompetensi Optional							
	Dasar SI	Manajemen Data dan Informasi	Infrastruktur TI	Komputasi Aman	Analisis dan Desain Sistem	Pengembangan Aplikasi dan Pemrograman	Etika SI	Manajemen dan Strategi SI	Manajemen Proyek SI	Praktikum SI	Analitik Data/Bisnis	Visualisasi Data/Informasi	Teknologi yang Muncul	Paradigm Berorientasi Objek	Web Programming	Pengembangan Seluler	Desain Antarmuka Pengguna	Inovasi Digital
Data/Analysis																		
Data Administrator																		
Data Analyst																		
Data scientist																		
Tech/Sec																		
Cloud Analyst																		
Network Executive																		
Security Executive																		
Dev/Prog																		
Sys Admin																		
System Analyst																		
Developer																		
UI/UX Designer																		
Solution Designer																		
System Architect																		
User Domain																		
Sales Consultant																		
Business Analyst																		
IT/Digital Consultant																		
	Light Green	Light Blue																
	Medium Green	Medium Blue																
	Dark Green	Dark Blue																

Pemula mendemonstrasikan penerapan pengetahuan dan keterampilan dasar yang sesuai dengan bidang kompetensi. Diharapkan untuk bekerja di bawah pengawasan dan memiliki sedikit keleluasaan. Diharapkan untuk mencari bimbingan dalam menyelesaikan masalah. (**SFIA Tingkat 1**)

Menengah mendemonstrasikan penerapan pengetahuan dan keterampilan penting yang sesuai dengan bidang kompetensi. Diharapkan untuk bekerja di bawah pengawasan untuk tugas-tugas rutin. Menggunakan kebijaksanaan terbatas dalam menyelesaikan masalah. (**SFIA Tingkat 2**)

Ahli mendemonstrasikan penerapan yang efektif dari pengetahuan dan keterampilan penting yang sesuai dengan bidang kompetensi. Diharapkan untuk mengerjakan tugas yang kompleks dan tidak rutin dengan pengawasan berkala. Menggunakan kebijaksanaan dalam menyelesaikan masalah. (**SFIA Tingkat 3**)

Profil Pekerjaan SI vs IS Competencies

The SFIA framework describes the skills and competencies required by professionals involved in information and communication technologies, digital transformation, and software engineering. There are seven levels of responsibility in the SFIA framework (Figure A1-2).



Figure A1-2 SFIA levels of responsibility
(<https://sfia-online.org/en/about-sfia/how-sfia-works>)

Each level of responsibility is characterized by five generic attributes:

- Autonomy
- Influence
- Complexity
- Knowledge
- Business skills

1	Level of Responsibility	7
Works under supervision	Autonomy	Full authority and accountability
Minimal influence	Influence	Makes critical decisions
Routine/structured work	Complexity	Unstructured complex work
Follows org. standards	Business skills	Strong leadership
Basic general knowledge	Knowledge	Deep business knowledge

Figure A1-3 Five generic attributes associated with SFIA 7 (Brown, 2020)

IS2020 Model Kompetensi untuk Program Sarjana Sistem Informasi

Kelompok-Kelompok Kompetensi dan Bidang-Bidang Kompetensi

Kelompok Kompetensi		Bidang Kompetensi		Core/ Optional
1	Dasar (Foundations)	K1	Dasar-Dasar Sistem Informasi (Foundations of Information System)	C
2	Data dan Informasi	K2	Manajemen Data dan Informasi (termasuk Basis Data)	C
		K3	Analitik Data/Bisnis (Data/Business Analytics)	O
		K4	Visualisasi Data/Informasi (Data/Information Visualization)	O
3	Teknologi/Sekuriti	K5	Infrastruktur TI (IT Infrastructure) (termasuk jaringan, cloud)	C
		K6	Komputasi Aman (Secure Computing)	C
		K7	Teknologi yang Muncul (Emerging Technologies)	O
4	Pengembangan (Development)	K8	Analisis dan Desain Sistem (System Analysis and Design)	C
		K9	Pengembangan Aplikasi dan Pemrograman (Application Development ad Programming)	C
		K10	Paradigma Berorientasi Obyek (Object-Oriented Paradigm)	O
		K11	Pengembangan Web (Web Development)	O
		K12	Pengembangan Seluler (Mobile Development)	O
		K13	Desain Antarmuka Pengguna (User Interface Design)	O
5	Domain Organisasi	K14	Etika SI, Keberlanjutan, Penggunaan, dan Implikasinya bagi Masyarakat	C
		K15	Manajemen dan Strategi SI (IS Management and Strategy)	C
		K16	Inovasi Digital (Digital Inovation)	O
		K17	Manajemen Proses Bisnis (Business Process Management)	O
6	Integrasi	K18	Manajemen Proyek SI (IS Project Management)	C
		K19	Praktikum SI (IS Practicum)	C



BOLD: Core (Disyarat)

ASOSIASI PERGURUAN TINGGI INFORMATIKA DAN KOMPUTER

Learning Outcomes and Competencies

■ Learning Outcome (LO)

- “relate to the knowledge, skills, and behaviors that students acquire as they progress through the program” (ABET)
 - Example: Acquire system requirements specification skills

■ Competency (CE)

- What an individual is able to *DO* on completing a course (Baumgartner and Shankararaman. 2013)
- **CC2020**

Competencies = Knowledge (K) + Skills (S) + Dispositions (D)

- Competency Leaf Framework: *In the context of a competency, a disposition helps to order knowledge and skill in context; to connect the ability (knowledge and skill) with the follow-through of the appropriate behavior.* (Frezza et al., 2018)

Competency Model Based Approaches



- A common European framework for ICT Professionals in all industry sectors <http://www.ecompetences.eu/>
- Skills Framework for the Information Age
<https://www.sfia-online.org/en/framework/sfia-7> Skills framework for career exploration and job analysis
<https://www.skillsfuture.sg/skills-framework/ict>
- Tool for career exploration and job analysis
<https://www.onetonline.org/>
- Skills framework for career exploration and job analysis
<https://www.skillsfuture.sg/skills-framework/ict>

Competencies CC2020

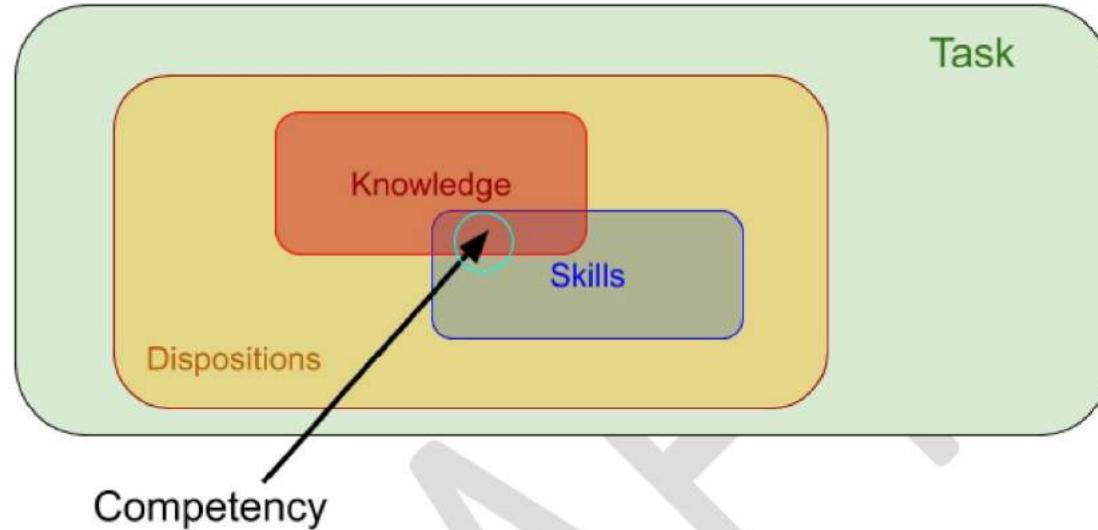


Figure 3- 1 Relationship Among Competency Components (CC2020 Draft, 2020)

$$\text{Competencies} = \text{Knowledge (K)} + \text{Skills (S)} + \text{Dispositions (D)}$$

- **Knowledge** - a fact/idea that enables satisfactory performance of relevant tasks
- **Skill** - a degree of mastery in applying a fact/idea to achieve a valued outcome
- **Dispositions** - values and motivation that moderates skilled behavior to influence a quality of professional performance

Various values that can be applied to *Knowledge*, *Skills* and *Dispositions*

Example of Knowledge, Skills, and Dispositions from CC2020

Knowledge	Skills	Dispositions
Factual	Remember	Meticulous
Conceptual	Understand	Responsive
Procedural	Apply	Collaborative
Metacognitive	Analyze	Adaptable
	Evaluate	Responsible
	Create	Professional
		Purpose driven
		Passionate
		Self-directed
		Meticulous

Proposed Curriculum Architecture

The structure is divided into **two Levels**.

Level 1 includes the **six major** elements: ***Program, Program Learning Outcome, Competency Realm, Competency Area, Competency Statement and Course.***

Level 2 includes Course Learning Outcome and Competency which is further defined through 3 elements namely ***Knowledge, Skill, and Disposition.***

Each Competency Area (CA) has a set of detailed Competencies. These Competencies are defined using a combination of Competency Statement, Knowledge, Skills and Dispositions that one must have to demonstrate a specific competency under a Competency Area.

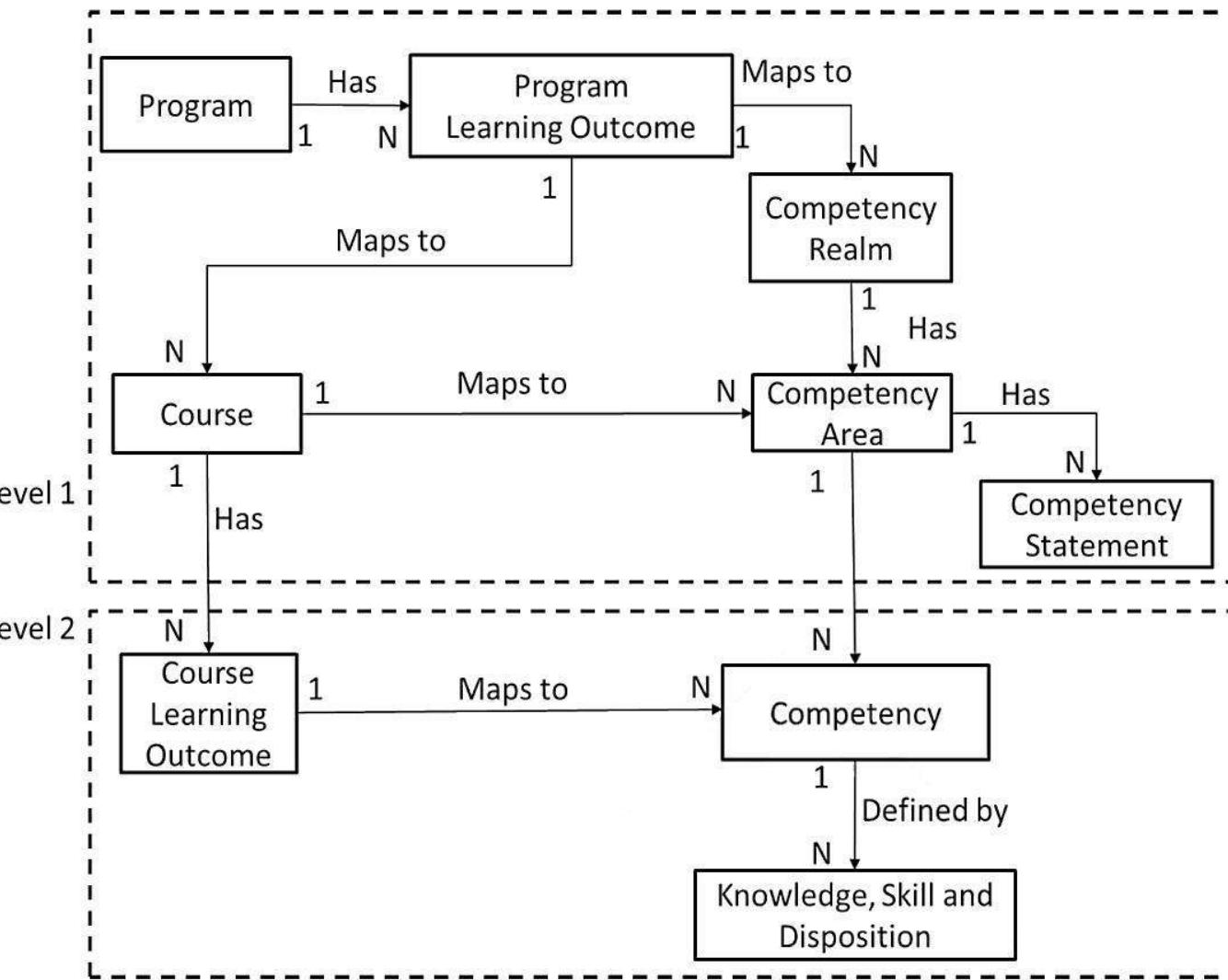
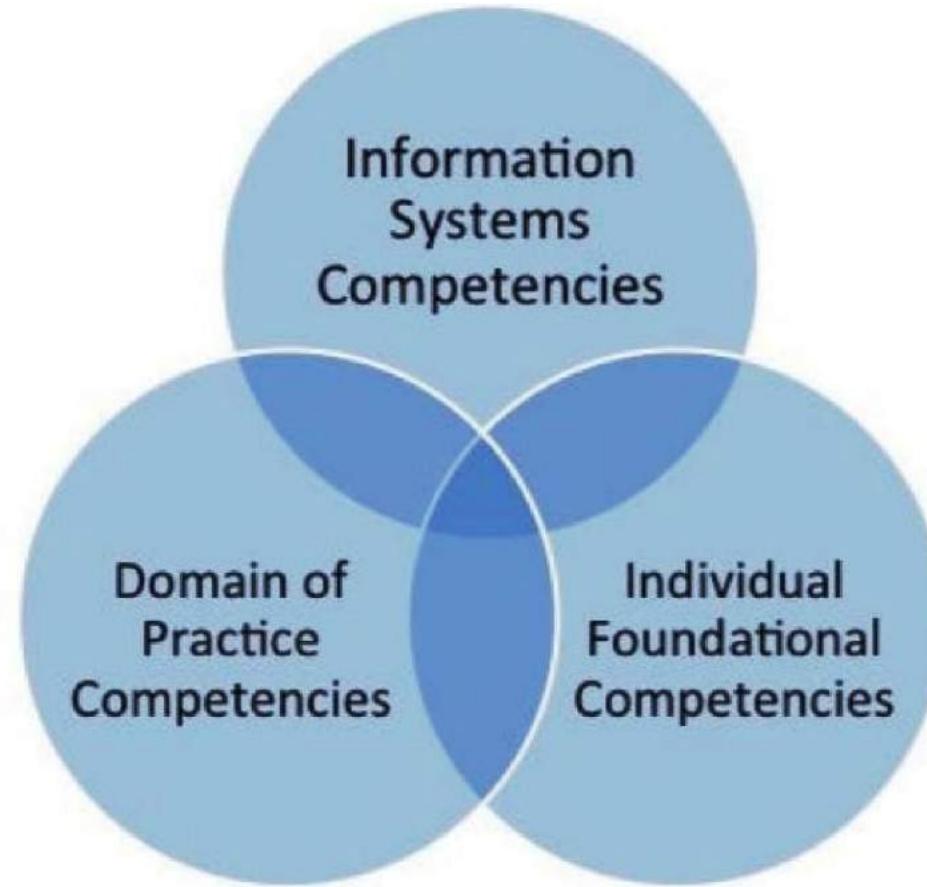


Figure 3-3 Proposed Curriculum Architecture

High Level Competency Realms



*Figure 4-1 IS2020 High level competency realms
(originally presented in IS2010, adapted to competency model for MSIS2016)*

Individual Foundational Competencies

■ Critical Thinking and Problem Solving:

- IS professionals must be capable of logical and analytical thinking.
- Working with and analyzing large complex data to make effective decisions is an essential competency area.
- Core (soft) skills associated with logical and analytical thinking and decision-making processes must be learned and developed to be an effective IS professional.
- In addition, IS professionals must be effective problem solvers.

■ Lifelong Learning and Development:

- As technology advances rapidly, IS professionals must adopt a continuous learning orientation and a mindset that embraces change. Competencies associated with learning how to learn and continuous growth and development are required core skills.

■ High Tolerance for Ambiguity:

- IS professionals work in a complex profession and it is often not possible to completely understand an information systems and the system's relationships with other entities and people. Hence, IS professionals must be adept and working with and adapting to ambiguous situations with incomplete information.
- Soft skills associated with managing and adapting to complex environments with incomplete information are required.

Domain of Practice Competencies

- Domain of practice competencies refer to knowledge, skills, and dispositions that graduates possess that are relevant to a domain.
 - An IS professional should possess domain competencies that, when combined with IS competencies, enable an IS practitioner to design, deliver and use information systems for the benefit of an entity in a domain of practice.
 - Knowledge of one domain of practice (e.g. understanding of organizational structures, technology and processes, values, ethical questions and concerns, legislation) will assist in learning similar issues in another domain, and in general highlights the critical need of understanding the domain of use as an important consideration in designing IS applications, including transfer of such applications from one
- Catatan:
 - **IS 2010** report defines business in general as the most common domain, but also identifies many others, such as business specialties (for example accounting and finance), government, health care, the legal profession and non-governmental organizations.
 - **MSIS 2016** further identified scientific research, education (K-12 and post-secondary) as additional potential domains.

SAMPLE COMPETENCY DIGITAL INNOVATION

Competency Statement:

New information technologies are transforming how innovations are created, distributed, and commercialized. Explores theoretical and practical aspects of emerging and existing digital innovation, their potential impact, disruption, and transformation on business and society. It is advised that this should occur through practical hands-on application and theoretical business modeling. The practical implications of digital innovation and entrepreneurship focus on the practices for digital innovation creation, distribution, and commercialization as well as the necessary digital strategies for management.

Competencies:

1. Articulate and critically reflect on the unique features that an application of emerging technology may offer.
2. Demonstrate knowledge of the role of digital business technologies in social and mobile domains.
3. Identify and critique characteristics necessary for digital innovation.
4. Identify and validate an opportunity to develop a new digital business model
5. Identify and evaluate key issues related to implementation and infrastructure issues.
6. Identify and assemble the required resources, processes, and partners to bring a digital business model to fruition
7. Practically demonstrate the investigation and application of a new innovation

Competence 1: Articulate and critically reflect on the unique features that an application of emerging technology may offer.

Knowledge/Skill Pairs:

Knowledge Element	Skill Level Bloom's Cognitive Level)
Emerging digital technology areas	1 - Remember
Methods to learn about emerging technology areas	3 - Apply
Methods to articulate and critically reflect offerings of a particular new digital technology	3 - Apply

SAMPLE COMPETENCY AREA STATEMENT

IS ETHICS, SUSTAINABILITY, USE AND IMPLICATIONS FOR SOCIETY

The IS ethics, sustainability, use, and implications for society competency area is concerned with practices associated with the ethical use of information systems and the ethical use of the information and data captured by such systems; designing, implementing, and using computing resources in a sustainable environmentally conscious manner; and competencies associated with how information systems may be used and created for the benefit of society.

1. Ethics, within the information systems ecosystem, reflects agreed moral codes of practices and control associated with the use of information systems through the: collection of data, the creation & storage and its sharing of information. As such ethical codes that govern both the use or dissemination of data must apply to both the information systems and the society in which it exists. The information system practitioner must be cognizant of these ethical codes and its implications for society.

Students will explore and understand the societal implications of disseminating information.

2. Information systems sustainability reflects an imperative that such systems and their data sources must be adaptable, relevant to all stake-holders and support the maintenance of data captured by such systems; through its design, implementation, and use of computing resources. Such data is constantly transformed through sustainable process, actions and performance to support the organization, individual and society at large.

SAMPLE COMPETENCIES IS ETHICS, SUSTAINABILITY, USE AND IMPLICATIONS FOR SOCIETY

- 1. Explore and understand aspects of ethical behaviour regarding the collection of data.**
2. Explore and understand the moral issues surrounding the storage and use of data.
3. Understand widely used ethical philosophies and how to apply them to situations that lead to ethical computing practices
- 4. Investigate ethical codes of practice and their implications for society.**
5. Understand aspects of sustainability and adaptable systems and data sources.
6. Explore stakeholders and their relevance to IS.
7. Investigate sustainable processes, actions and performance to support organisations.
8. Investigate sustainable processes, actions and performance to support the individual.
9. Investigate sustainable processes, actions and performance to support society at large.

SAMPLE KNOWLEDGE / SKILL PAIRS IS ETHICS, SUSTAINABILITY, USE AND IMPLICATIONS FOR SOCIETY

Competency 1:

Explore and understand aspects of ethical behaviour regarding the collection of data.

Knowledge Element	Skill Level (Bloom's Cognitive Level)
International laws and regulations governing the collection of data	2 - Understand
Country specific laws and regulations governing the collection of data	2 - Understand
State and local laws governing the collection of data	2 - Understand
How data is collected via mobile devices	2 - Understand
How data is collection via websites	2 - Understand
How data is collected via social media	2 - Understand
How data is collected via email	2 - Understand
How data is collected via wearable devices	2 - Understand
How data is collection via websites	2 - Understand
How data is collected via social media	2 - Understand
How data is collected via email	2 - Understand
How data is collected via wearable devices	2 - Understand
Common ethical philosophical frameworks	2 - Understand
Basic principles governing ethical decision making	2 - Understand

SAMPLE COMPETENCY AREA STATEMENT

APPLICATION DEVELOPMENT AND PROGRAMMING

A key function of any information system is an ability to transform data into information in support of organizational or personal goals. The software that developed in parallel to operate computer hardware has evolved to extend the utility of computation has evolved into myriad applications that are both pervasive and ubiquitous in everyday life. Thus, the principle importance of this facet of the IS curriculum is twofold:

1. **Programming** is the language of computation and logic that sequences and orders instructions to computing hardware in a manner that realizes both correct results and discernable results. Logical structures, algorithms, arithmetic facilities, and the ability to input, store, transform, and output data that can be purposefully used to inform decisions and automated intentional processes are at the heart of learning to program. To program a computer is to meet the computer “in the middle” such that the growing capabilities of data and computing can be purposefully guided. Programming is meant to shape the mind and reasoning such that human requirements for data and computing outcomes can be expressed and perfected.
2. **Application Development** is the purposeful application of programming fundamentals to craft usable and useful software artifacts and systems to solve actionable business and organizational problems where the power and automation of computing and data processing is warranted. Elements of design, to include reconciliation between human social systems and data and information systems, support a software/systems development life-cycle where the industry and craft software realization extend capabilities of software and programming code elements and our understanding of fit and resonance with the human end-users of these systems. In this regard, an information systems perspective on application development, although akin to software engineering, includes the necessary elements of human-computer interaction, user experience, and other sociological and psychological components that constitute user and organizational acceptance and satisfaction.

SAMPLE COMPETENCIES

APPLICATION DEVELOPMENT AND PROGRAMMING

Programming-Related Competencies:

1. Develop data storage strategies using primitive data types in a computer's volatile memory
2. Apply data transformations using arithmetic, assignment, and transpositional operators
3. Develop predicate expressions using relational and logical operators
4. Express algorithmic problem solving using sequence, selection, and repetition structures
5. Modularize the algorithmic and operating capabilities of a program using functions, methods, subroutines or similar organizing structures.
6. Select and utilize appropriate linear and non-linear data structures to maintain and manage sets of related data in non-volatile memory.
7. Utilize Object-Oriented concepts in the organization and structuring of programs for behavior and concept management

Application Development Related Competencies:

8. Conduct a systematic requirements analysis to determine the basic facts used to organize the application of programming effort to solve a problem or reach a goal
9. Formalize and communicate requirements in a manner that is comprehensible for all stakeholders that will determine the success of the software system
10. Specify the software system architecture such that the principal components and dependencies of the system are visible and comprehensible for all involved in shaping the materials of design and construction
11. Identify the lateral components and libraries that the designed and developed system will depend on
12. Develop the programming code implementation that realizes the system architecture and design.
13. Test all developed programming code components to ensure fidelity, consistency, and fit.
14. Maintain software throughout deployment and utilization such that extant or new intentions and requirements are accommodated such that the intended purpose will function.
15. Adopt, or adapt, an appropriate software systems process methodology such that people, resources, design requirements and other dynamic considerations allow for correctness and utility.
16. Establish and maintain the appropriate dialog among stakeholders that ensure a degree of communication and information transparency to maintain the viability of the software system.

SAMPLE KNOWLEDGE / SKILL PAIRS

APPLICATION DEVELOPMENT AND PROGRAMMING

Competency 3:

Develop predicate expressions using relational and logical operators

Knowledge Element	Skill Level (Bloom's Cognitive Level)
How mathematical expressions resolve multiple operations to a single value	2 - Understand
Develop Boolean predicates utilize relational operators	3 - Apply
Develop compound predicate expressions using logical operators	3 - Apply
The relationship between logical operations and computer processor architectures	2 - Understand

Bloom's (Revised) of Educational Objectives: Facets of Learning (Anderson, 2001)



Revised Bloom's Taxonomy Action Verbs Along the Cognitive Process Dimension

Definitions	I.Remembering	II.Understanding	III.Applying	IV.Analyzing	V.Evaluating	VI.Creating
Bloom's Definition	Exhibit memory of previously learned materials by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas.	Solve problems to new situations by applying acquired knowledge, facts, techniques and rules in a different way.	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations.	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria.	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions.
Verbs	Choose	Classify	Apply	Analyze	Agree	Adapt
	Define	Compare	Build	Assume	Appraise	Build
	Find	Contrast	Choose	Categorize	Assess	Change
	How	Demonstrate	Construct	Classify	Award	Choose
	Label	Explain	Develop	Compare	Choose	Combine
	List	Extend	Experiment with	Conclusion	Compare	Compile
	Match	Illustrate	Identify	Contrast	Conclude	Compose
	Name	Infer	Interview	Discover	Criteria	Construct
	Omit	Interpret	Make use of	Dissect	Criticize	Create
	Recall	Outline	Model	Distinguish	Decide	Delete
	Relate	Relate	Organize	Divide	Deduct	Design
	Select	Rephrase	Plan	Examine	Defend	Develop
	Show	Show	Select	Function	Determine	Discuss
	Spell	Summarize	Solve	Inference	Disprove	Elaborate
	Tell	Translate	Utilize	Inspect	Estimate	Estimate
	What			List	Evaluate	Formulate
	When			Motive	Explain	Happen
	Where			Relationships	Importance	Imagine
	Which			Simplify	Influence	Improve
	Who			Survey	Interpret	Invent
	Why			Take part in	Judge	Make up
				Test for	Justify	Maximize
				Theme	Mark	Minimize
					Measure	Modify
					Opinion	Original
					Perceive	Originate
					Prioritize	Plan
					Prove	Predict
					Rate	Propose
					Recommend	Solution
					Rule on	Solve
					Select	Suppose

*Revised Bloom's
Taxonomy Action Verbs
Along the Cognitive
Process Dimension*

Prospective Taxonomy of Dispositions

<u>Disposition</u>	<u>Elaboration</u>
Proactive	<i>With Initiative</i> (Nwokeji, Stachel, & Holmes, 2019) / <i>Self-Starter</i> (Clear, 2017) Shows independence. Ability to assess and start activities independently without needing to be told what to do. Willing to take the lead, not waiting for others to start activities or wait for instructions.
Self-Directed	<i>Self-motivated</i> (Clear, 2017) / <i>Self-Directed</i> (Nwokeji et al., 2019) Demonstrates determination to sustain efforts to continue tasks. Direction from others is not required to continue a task toward its desired ends.
Passionate	<i>With Passion</i> (Nwokeji et al., 2019), (Clear, 2017) / <i>Conviction</i> (Gray, 2015) Strongly committed to and enthusiastic about the realization of the task or goal. Makes the compelling case for the success and benefits of task, project, team or means of achieving goals.
Purpose-Driven	<i>Purposefully engaged</i> / <i>Purposefulness</i> (Nwokeji et al., 2019), (Clear, 2017) Goal-directed, intentionally acting and committed to achieve organizational and project goals. Reflects an attitude towards the organizational goals served by decisions, work or work products. e.g., Business acumen.
Professional	<i>With Professionalism</i> / <i>Work ethic</i> (Nwokeji et al., 2019) Reflecting qualities connected with trained and skilled people: Acting honestly, with integrity, commitment, determination and dedication to what is required to achieve a task.
Responsible	<i>With Judgement</i> / <i>Discretion</i> (Nwokeji et al., 2019) / <i>Responsible</i> (Clear, 2017) / <i>Rectitude</i> (Grey, 2015) Reflect on conditions and concerns, then acting according to what is appropriate to the situation. Making responsible assessments and taking actions using professional knowledge, experience, understanding and common sense. E.g., Responsibility, Professional astuteness (Grey, 2015).
Adaptable	<i>Adaptable</i> (Nwokeji et al., 2019) / <i>Flexible</i> (Clear, 2017) / <i>Agile</i> (Weber, 2017) Ability or willingness to adjust approach in response to changing conditions or needs.
Collaborative	<i>Collaborative</i> (Weber, 2017) / <i>Team Player</i> (Clear, 2017) / <i>Influencing</i> (Nwokeji et al., 2019) Willingness to work with others; engaging appropriate involvement of other persons and organizations helpful to the task. Striving to be respectful and productive in achieving a common goal.
Responsive	<i>Responsive</i> (Weber, 2017) / <i>Respectful</i> (Clear, 2017) Reacting quickly and positively. Respecting the timing needs for communication and actions needed to achieve the goals of the work.
Meticulous	<i>Attentive to Detail</i> (Weber, 2017), (Nwokeji et al., 2019) Achieves thoroughness and accuracy when accomplishing a task through concern for relevant details.

Pendidikan bukanlah tentang kemampuan untuk mengingat dan mengulang, di mana orang belajar untuk lulus ujian, dan mengajar orang lain untuk lulus ujian, **tetapi tidak ada yang tahu apa-apa.**

Pendidikan adalah **tentang kemampuan untuk belajar dari pengalaman, untuk berpikir, memecahkan masalah, dan menggunakan pengetahuan kita untuk beradaptasi dengan situasi baru.**

Terima Kasih



Knowledge Wajib Setiap Prodi INFOKOM dan Knowledge Inti Per Prodi INFOKOM Berdasarkan CC2020

Achmad Benny Mutiara

Dekan Fakultas Ilmu Komputer dan Teknologi Informasi, Universitas Gunadarma

SEKJEN-APTIKOM

2021

Analysis and Visualization of Curricula

Visualization of the Landscape of Computing Knowledge Table



Visualization of the Landscape of Computing Knowledge Table

Table 5.3 Landscape of Computing Knowledge

		CE		CS		CSEC		IS		IT		SE	
		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
1. Users and Organizations	1.1. Social Issues and Professional Practice	2	5	2	4	2	4	3	5	2	4	3	5
	1.2. Security Policy and Management	1	3	2	3	4	5	2	3	2	4	2	4
	1.3. IS Management and Leadership	0	2	0	2	1	2	4	5	1	2	1	2
	1.4. Enterprise Architecture	0	1	0	1	1	2	3	5	1	3	1	3
	1.5. Project Management	1	3	2	3	1	2	4	5	2	3	2	4
	1.6. User Experience Design	1	3	2	4	1	3	2	4	3	4	3	5
2. Systems Modeling	2.1. Security Issues and Principles	2	3	2	3	4	5	2	4	3	4	2	4
	2.2. Systems Analysis & Design	1	2	1	2	1	2	4	5	1	3	2	4
	2.3. Requirements Analysis and Specification	1	2	1	2	0	2	2	4	1	3	3	5
	2.4. Data and Information Management	1	2	2	4	2	3	3	5	2	3	2	4
3. Systems Architecture and Infrastructure	3.1. Virtual Systems and Services	1	3	1	3	1	2	1	2	3	4	1	3
	3.2. Intelligent Systems (AI)	1	3	3	5	1	2	1	2	1	2	0	1
	3.3. Internet of Things	2	4	0	2	1	3	1	3	2	4	1	3
	3.4. Parallel and Distributed Computing	2	4	2	4	1	2	1	3	1	3	2	3
	3.5. Computer Networks	2	4	2	4	2	4	1	3	3	4	2	2
	3.6. Embedded Systems	3	5	0	2	1	3	0	1	0	1	0	3
	3.7. Integrated Systems Technology	1	2	0	2	0	2	1	3	3	4	1	3
	3.8. Platform Technologies	0	1	1	2	1	2	1	3	2	4	0	2
	3.9. Security Technology and Implementation	2	3	2	4	4	5	1	3	2	4	2	4

Visualization of the Landscape of Computing Knowledge Table

4. Software Development	4.1. Software Quality, Verification and Validation	1	3	1	3	1	2	1	3	1	2	3	5
	4.2. Software Process	1	2	1	3	0	2	1	3	1	3	3	5
	4.3. Software Modeling and Analysis	1	3	1	3	1	2	2	4	1	3	4	5
	4.4. Software Design	2	4	2	4	1	3	1	3	1	2	4	5
	4.5. Platform-Based Development	0	2	2	4	0	1	1	3	2	4	1	3
5. Software Fundamentals	5.1. Graphics and Visualization	1	2	2	4	0	1	1	1	0	1	0	2
	5.2. Operating Systems	2	4	3	5	2	3	1	2	1	3	1	3
	5.3. Data Structures, Algorithms and Complexity	2	4	4	5	1	3	1	3	1	2	2	4
	5.4. Programming Languages	2	3	3	5	1	2	1	2	1	2	2	3
	5.5. Programming Fundamentals	2	4	4	5	2	3	1	3	2	4	3	5
	5.6. Computing Systems Fundamentals	2	3	2	3	1	2	2	3	1	3	2	3
6. Hardware	6.1. Architecture and Organization	4	5	3	4	1	3	1	2	1	2	1	3
	6.2. Digital Design	4	5	1	2	0	2	0	1	0	1	0	2
	6.3. Circuits and Electronics	4	5	1	2	0	1	0	1	1	2	0	1
	6.4. Signal Processing	3	4	0	1	0	2	0	1	0	1	0	1

Knowledge Wajib Setiap Prodi Infokom

Berdasarkan tabel visualisasi 5.3 dengan Asumsi ketika ada bobot knowledge 0, ini berarti **tidak wajib** untuk setiap prodi infokomm. Ada **20 Knowledge Wajib** Setiap Prodi adalah sbb:

- | | | | | | |
|----|--|-----|--|-----|---|
| 1) | 1.1. Social Issues and Professional Practice | 8) | 3.1. Virtual Systems and Services | 15) | 5.2. Operating Systems |
| 2) | 1.2. Security Policy and Management | 9) | 3.4. Parallel and Distributed Computing | 16) | 5.3. Data Structures, Algorithms and Complexity |
| 3) | 1.5. Project Management | 10) | 3.5. Computer Networks | 17) | 5.4. Programming Languages |
| 4) | 1.6. User Experience Design | 11) | 3.9. Security Technology and Implementation | 18) | 5.5. Programming Fundamentals |
| 5) | 2.1. Security Issues and Principles | 12) | 4.1. Software Quality, Verification and Validation | 19) | 5.6. Computing Systems Fundamentals |
| 6) | 2.2. Systems Analysis & Design | 13) | 4.3. Software Modeling and Analysis | 20) | 6.1. Architecture and Organization |
| 7) | 2.4. Data and Information Management | 14) | 4.4. Software Design | | |

Knowledge Inti Prodi Sistem Komputer

Ada 8 knowledge inti untuk Prodi Sistem Komputer

- 1) 3.3. Internet of Things
- 2) 3.4. Parallel and Distributed Computing
- 3) 3.6. Embedded Systems
- 4) 5.6. Computing Systems Fundamentals
- 5) 6.1. Architecture and Organization
- 6) 6.2. Digital Design
- 7) 6.3. Circuits and Electronics
- 8) 6.4. Signal Processing

Knowledge Inti Prodi Ilmu Komputer

Ada 9 knowledge inti untuk Prodi Ilmu Komputer

- 1) 3.2. Intelligent Systems (AI)
- 2) 3.4. Parallel and Distributed Computing
- 3) 4.5. Platform-Based Development
- 4) 5.1. Graphics and Visualization
- 5) 5.2. Operating Systems
- 6) 5.3. Data Structures, Algorithms and Complexity
- 7) 5.4. Programming Languages
- 8) 5.5. Programming Fundamentals
- 9) 5.6. Computing Systems Fundamentals

Knowledge Inti Prodi Cyber Security

Ada 3 knowledge inti untuk Prodi Ilmu Komputer

- 1) 1.2. Security Policy and Management
- 2) 2.1. Security Issues and Principles
- 3) 3.9. Security Technology and Implementation

Knowledge Inti Prodi Sistem Informasi

Ada 7 knowledge inti untuk Prodi Ilmu Komputer

- 1) 1.1. Social Issues and Professional Practice
- 2) 1.3. IS Management and Leadership
- 3) 1.4. Enterprise Architecture
- 4) 1.5. Project Management
- 5) 2.2. Systems Analysis & Design
- 6) 2.4. Data and Information Management
- 7) 5.6. Computing Systems Fundamentals

Knowledge Inti Prodi Teknologi Informasi

Ada 6 knowledge inti untuk Prodi Ilmu Komputer

- 1) 3.1. Virtual Systems and Services
- 2) 3.3. Internet of Things
- 3) 3.5. Computer Networks
- 4) 3.7. Integrated Systems Technology
- 5) 3.8. Platform Technologies
- 6) 4.5. Platform-Based Development

Knowledge Inti Prodi Rekayas Perangkat Lunak

Ada 6 knowledge inti untuk Prodi Ilmu Komputer

- 1) 1.1. Social Issues and Professional Practice
- 2) 1.6. User Experience Design
- 3) 2.3. Requirements Analysis and Specification
- 4) 4.1. Software Quality, Verification and Validation
- 5) 4.2. Software Process
- 6) 4.3. Software Modeling and Analysis
- 7) 4.4. Software Design
- 8) 5.6. Computing Systems Fundamentals

Pendidikan **bukanlah** tentang kemampuan untuk mengingat dan mengulang, di mana orang belajar untuk lulus ujian, dan mengajar orang lain untuk lulus ujian, **tetapi tidak ada yang tahu apa-apa.**

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Terima Kasih



Model Arsitektur BoK Kurikulum Infokom Berdasarkan CC 2020 dan Contoh Gambar BoK Kurikulum

Achmad Benny Mutiara

Dekan Fakultas Ilmu Komputer dan Teknologi Informasi, Universitas Gunadarma

SEKJEN-APTIKOM

2022

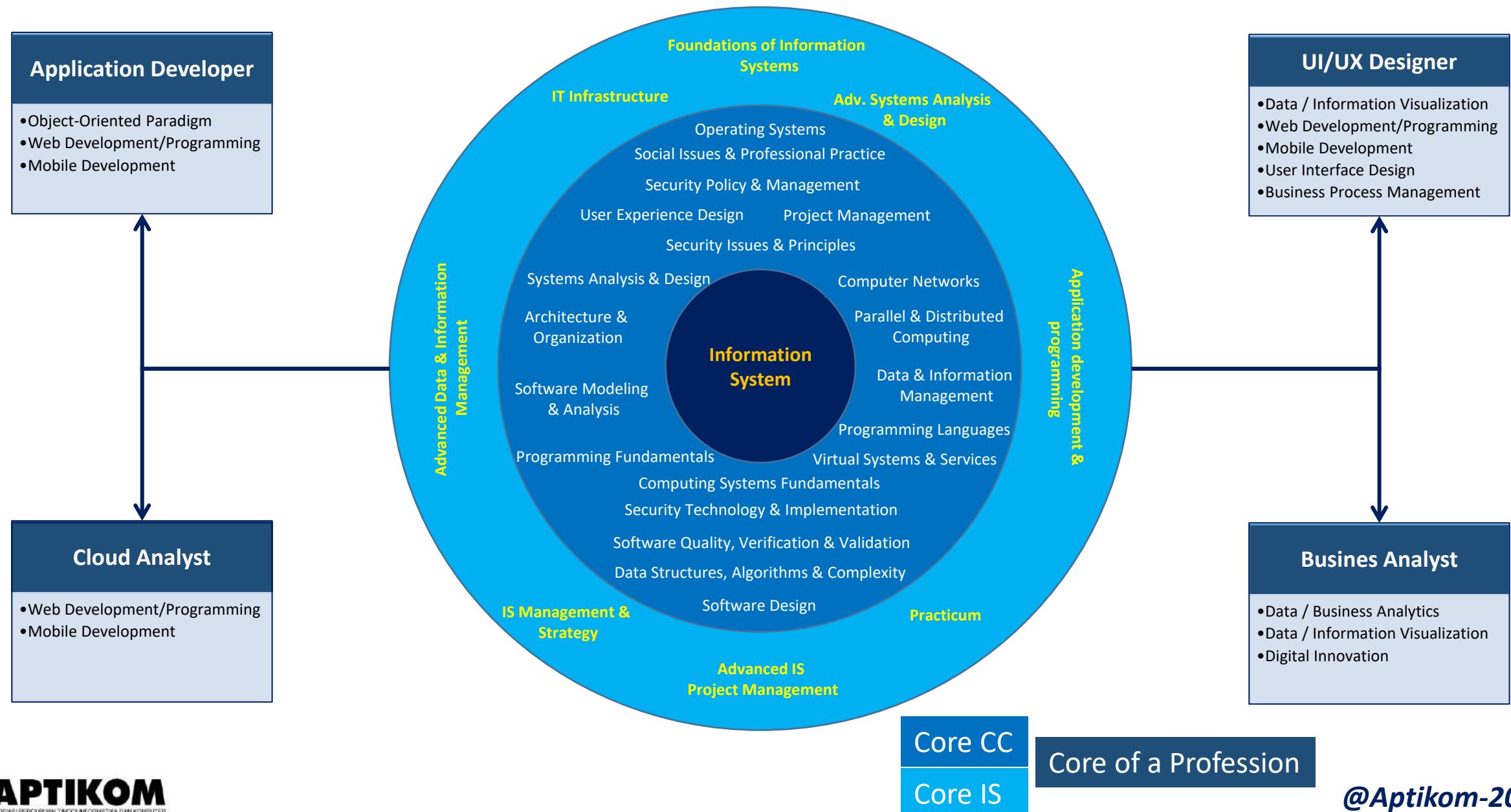
Model Arsitektur Kurikulum Infokom Berdasarkan CC 2020

Bobot	Pengetahuan Wajib Setiap Prodi INFOKOM							
	1	Social Issues and Professional Practice	6	Systems Analysis & Design	11	Security Technology and Implementation	16	Data Structures, Algorithms & Complexity
	2	Security Policy and Management	7	Data and Information Management	12	Software Quality, Verification and Validation	17	Programming Languages
	3	Project Management	8	Virtual Systems and Services	13	Software Modeling and Analysis	18	Programming Fundamentals
	4	User Experience Design	9	Parallel and Distributed Computing	14	Software Design	19	Computing Systems Fundamentals
	5	Security Issues and Principles	10	Computer Networks	15	Operating Systems	20	Architecture and Organization
Pengetahuan Inti per Prodi Infokom								
Sistem Komputer		Ilmu Komputer		Cyber Security		Sistem Informasi		
1	Internet of Things	1	Intelligent Systems (AI)	1	Security Policy and Management	1	Social Issues and Professional Practice	
2	Parallel and Distributed Computing	2	Parallel and Distributed Computing	2	Security Issues and Principles	2	IS Management and Leadership	
3	Embedded Systems	3	Platform-Based Development	3	Security Technology and Implementation	3	Enterprise Architecture	
4	Computing Systems Fundamentals	4	Graphics and Visualization			4	Project Management	
5	Architecture and Organization	5	Operating Systems			5	Systems Analysis & Design	
6	Digital Design	6	Data Structures, Algorithms & Complexity			6	Data and Information Management	
7	Circuits and Electronics	7	Programming Languages			7	Computing Systems Fundamentals	
8	Signal Processing	8	Programming Fundamentals					
		9	Computing Systems Fundamentals					
Teknologi Informasi		Rekayasa Perangkat Lunak		Sains Data		Kecerdasan Artificial		
1	Virtual Systems and Services	1	Social Issues and Professional Practice					
2	Internet of Things	2	User Experience Design					
3	Computer Networks	3	Requirements Analysis and Specification					
4	Integrated Systems Technology	4	Software Quality, Verification & Validation					
5	Platform Technologies	5	Software Process					
6	Platform-Based Development	6	Software Modeling and Analysis					
		7	Software Design					
		8	Computing Systems Fundamentals					
Pengetahuan untuk Profesi Sasaran								
Programmer		Database designer		Application Developer		Network Administrator		
1	1	1	1	...	
2	2	2	2	...	
3	3	3	3	
4	4	4	4	

Model Arsitektur Kurikulum Sistem Informasi Berdasarkan CC 2020 dan IS 2020

Bobot	Pengetahuan Wajib Setiap Prodi INFOKOM									
	1	Social Issues and Professional Practice	6	Systems Analysis & Design	11	Security Technology and Implementation	16	Data Structures, Algorithms & Complexity		
	2	Security Policy and Management	7	Data and Information Management	12	Software Quality, Verification and Validation	17	Programming Languages		
	3	Project Management	8	Virtual Systems and Services	13	Software Modeling and Analysis	18	Programming Fundamentals		
	4	User Experience Design	9	Parallel and Distributed Computing	14	Software Design	19	Computing Systems Fundamentals		
	5	Security Issues and Principles	10	Computer Networks	15	Operating Systems	20	Architecture and Organization		
Pengetahuan Inti per Prodi Infokom										
			Sistem Informasi CC 2020			Sistem Informasi IS 2020				
			1	Social Issues and Professional Practice	1	Foundations of Information Systems	1			
			2	IS Management and Leadership	2	Data / Info. Management (Ada di CC 2020)	2			
			3	Enterprise Architecture	3	IT Infrastructure	3			
			4	Project Management	4	IS Project Management (Ada di CC 2020)	4			
			5	Systems Analysis & Design	5	Systems Analysis & Design (Ada di CC 2020)	5			
			6	Data and Information Management	6	IS Management & Strategy	6			
			7	Computing Systems Fundamentals	7	Application development/programming (baru di IS 2020)	7			
					8	Secure computing (baru di IS2020)	8			
					9	Ethics, use and implications for society (Ada CC 2020)	9			
					10	Practicum	10			
Contoh Pengetahuan (Kompetensi di IS 2020) untuk Profesi Sasaran										
			UI/UX Designer			Application Developer			Busines Analyst	
			1	Data / Information Visualization	1	Object-Oriented Paradigm	1	Data / Business Analytics	1	Web Development/Programming
			2	Web Development/Programming	2	Web Development/Programming	2	Data / Information Visualization	2	Mobile Development
			3	Mobile Development	3	Mobile Development	3	Digital Innovation		
			4	User Interface Design						
			5	Business Process Management						

BoK of IS Curricula based on CC-2020 and IS-2020, and Sample Profession Knowledge



BoK of CE Curricula based on CC-2020 and CE-2016, and Sample Profession Knowledge



Model Arsitektur Kurikulum **Teknologi Informasi** Berdasarkan CC 2020 dan IT2017

Pengetahuan Wajib Setiap Prodi INFOKOM

1	Social Issues and Professional Practice	6	Systems Analysis & Design	11	Security Technology and Implementation	16	Data Structures, Algorithms & Complexity
2	Security Policy and Management	7	Data and Information Management	12	Software Quality, Verification and Validation	17	Programming Languages
3	Project Management	8	Virtual Systems and Services	13	Software Modeling and Analysis	18	Programming Fundamentals
4	User Experience Design	9	Parallel and Distributed Computing	14	Software Design	19	Computing Systems Fundamentals
5	Security Issues and Principles	10	Computer Networks	15	Operating Systems	20	Architecture and Organization

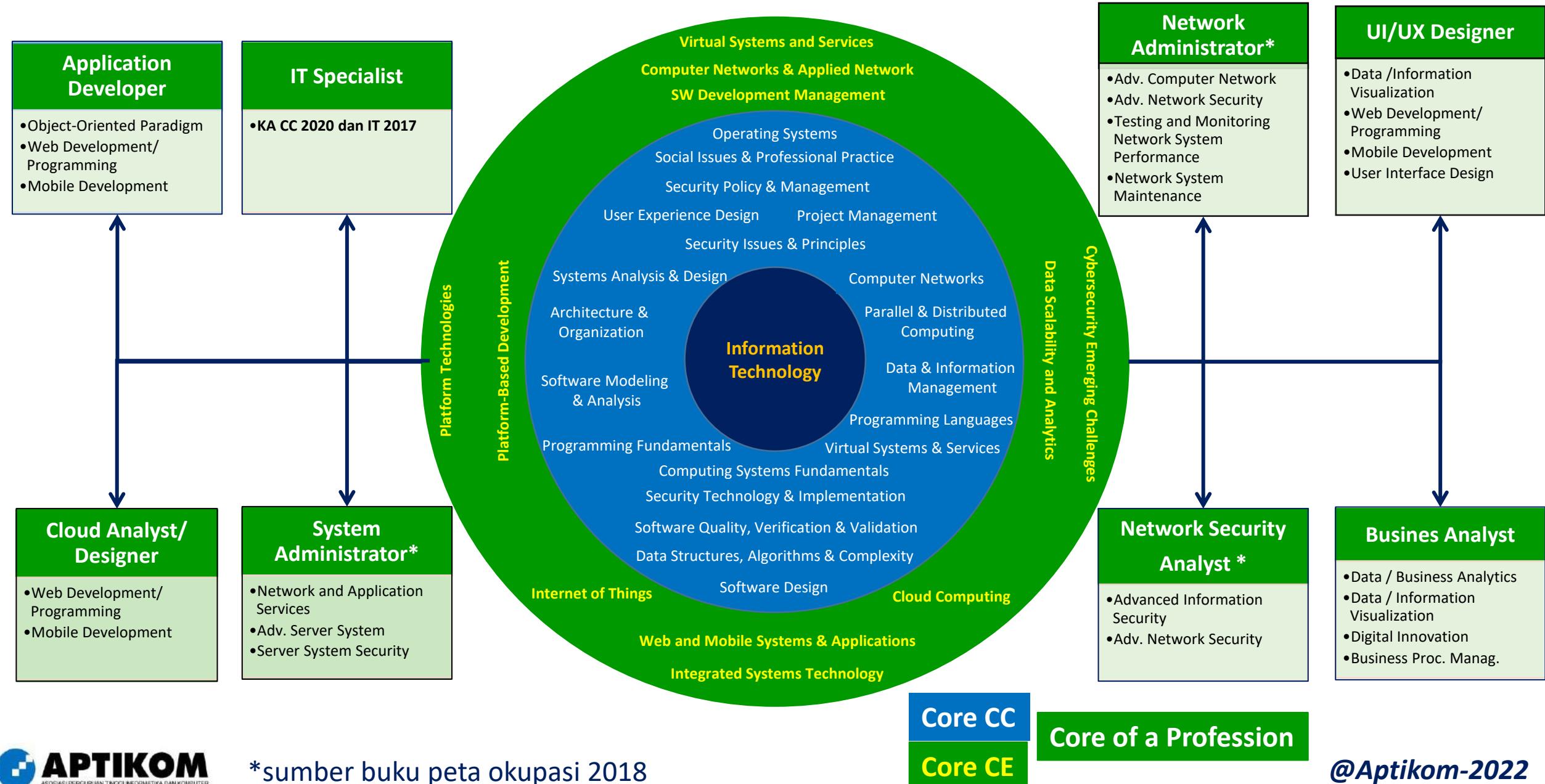
Pengetahuan Inti per Prodi Infokom

Teknologi Informasi CC 2020		Teknologi Informasi IT2017		Teknologi Informasi CC2020+IT2017	
		10 Essential Domains (40%)		9 Supplemental Domains (20%)	
1	Virtual Systems and Services	1	ITE-CSP Cybersecurity Principles (6%)	1	ITE-ANE Applied Networks (4%)
2	Internet of Things	2	ITE-GPP Global Professional Practice (3%)	2	ITE-CCO Cloud Computing (4%)
3	Computer Networks	3	ITE-IMA Information Management (6%)	3	ITE-CEC Cybersecurity Emerging Challenges (4%)
4	Integrated Systems Technology	4	ITE-IST Integrated Systems Technology (3%)	4	ITE-DSA Data Scalability and Analytics (4%)
5	Platform Technologies	5	ITE-NET Networking (5%)	5	ITE-IOT Internet of Things (4%)
6	Platform-Based Development	6	ITE-PFT Platform Technologies (1%)	6	ITE-MAP Mobile Applications (3%)
		7	ITE-SPA System Paradigms (6%)	7	ITE-SDM SW Development Management (2%)
		8	ITE-SWF Software Fundamentals (4%)	8	ITE-SRE Social Responsibility (2%)
	Warna merah dan hijau: ada di CC 2020	9	TTE-UXD User Experience Design (3%)	9	ITE-VSS Virtual Systems and Services (4%)
		10	ITE-WMS Web and Mobile Systems (3%)		Warna merah dan hijau: ada di CC 2020
					11 SW Development Management

Contoh Pengetahuan (Kompetensi di IT2017 dan Peta Okupasi) untuk Profesi Sasaran

IT Specialist		Network Security Analyst		System Administrator		Network Administrator	
1	KA CC 2020 dan IT 20117	1	Adv. Information Security	1	Network and Application Services	1	Adv. Computer Network
2		2	Adv. Network Security	2	Adv. Server System	2	Adv. Network Security
3				3	Server System Security	3	Testing and Monitoring Network System Performance
4						4	Network System Maintenance
UI/UX Designer		Application Developer		Business Analyst		Cloud Analyst/Designer	
1	Data / Information Visualization	1	Object-Oriented Paradigm	1	Data / Business Analytics	1	Web Development/Programming
2	Web Development/Programming	2	Web Development/Programming	2	Data / Information Visualization	2	Mobile Development
3	Mobile Development	3	Mobile Development	3	Digital Innovation		
4	User Interface Design			4	Business Process Management		

BoK of CE Curricula based on CC-2020 and IT-2017, and Sample Profession Knowledge

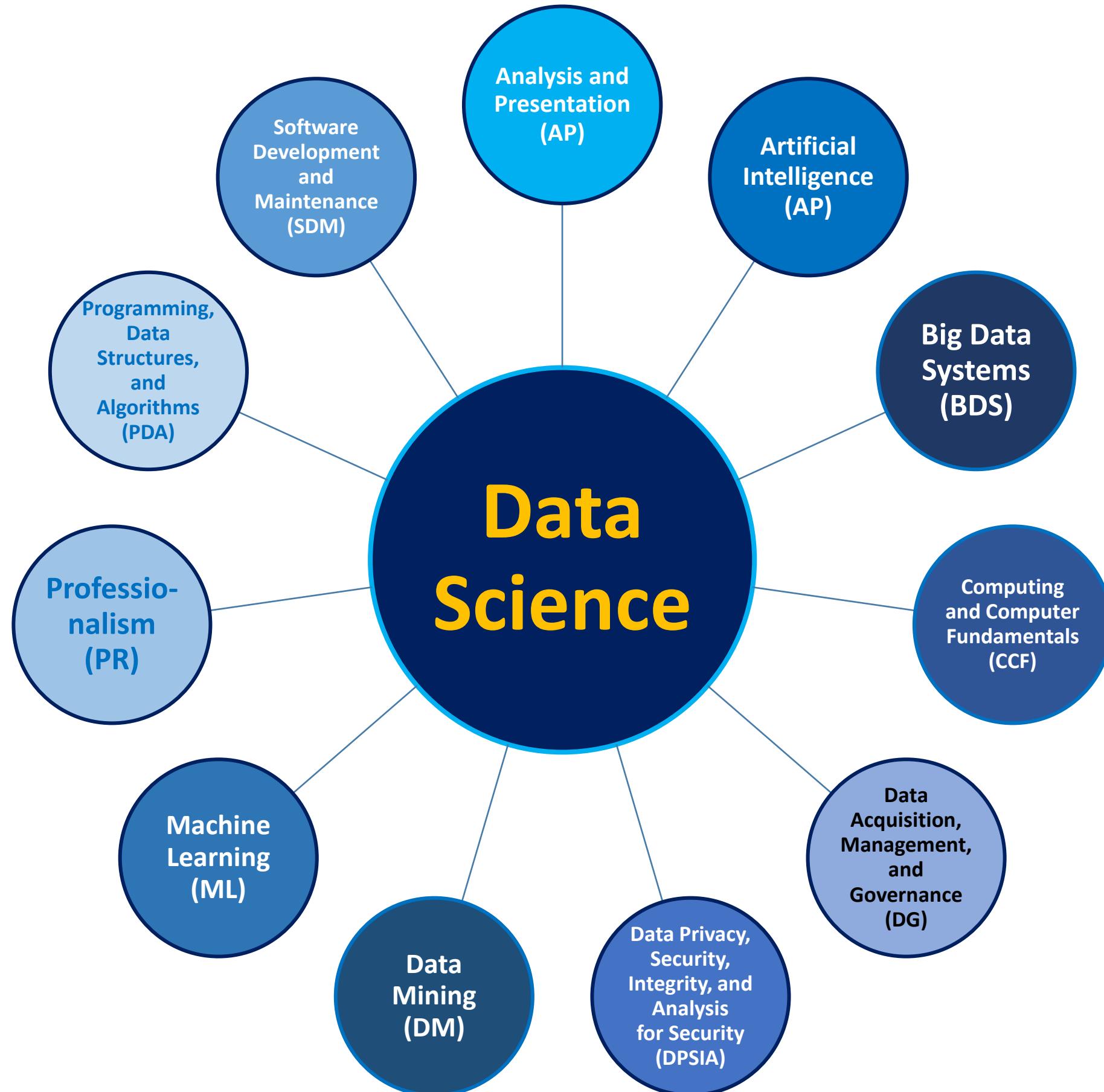


Model Arsitektur Kurikulum Sains Data Berdasarkan CC 2020, CCDSC 2021, dan IABAC

Bobot	Pengetahuan Wajib Setiap Prodi INFOKOM									
	1	Social Issues and Professional Practice	6	Systems Analysis & Design	11	Security Technology and Implementation	16	Data Structures, Algorithms & Complexity		
	2	Security Policy and Management	7	Data and Information Management	12	Software Quality, Verification and Validation	17	Programming Languages		
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	4	User Experience Design	9	Parallel and Distributed Computing	14	Software Design	19	Computing Systems Fundamentals		
	5	Security Issues and Principles	10	Computer Networks	15	Operating Systems	20	Architecture and Organization		
Pengetahuan Inti per Prodi Infokom										
Sains Data CCDSC 2021					Sains Data EDSF DS-BoK - Release 2, IABAC			Pengetahuan		
					Kelompok Bidang Pengetahuan			Pengetahuan		
		1	Analysis and Presentation (AP)	1	Data Analytics		1.1	Statistical Method for data analysis		
		2	Artificial Intelligence (AI)				1.2	Machine Learning		
		3	Big Data Systems (BDS)				1.3	Data Mining		
		4	Computing and Computer Fundamentals (CCF) (Ada CC2020)				1.4	Text Data Mining		
		5	Data Acquisition, Management, and Governance (DG)				1.5	Predictive Analytics		
		6	Data Mining (DM)				1.6	Computational modelling, simulation and optimisation		
		7	Data Privacy, Security, Integrity, and Analysis for Security (DP)	2	Data Science Engineering		2.1	Big Data Infrastructure and Technologies		
		8	Machine Learning (ML)				2.2	Infrastructure and platforms for Data Science applications		
		9	Professionalism (PR) (Ada di CC2020)				2.3	Cloud Computing technologies for Big Data and Data Analytics		
		10	Programming, Data Structures, and Algorithms (PDA) (Ada di CC2020)				2.4	Data and Applications security		
		11	Software Development and Maintenance (SDM) (Ada di CC2020)				2.5	Big Data systems organisation and engineering		
							2.6	Data Science (Big Data) applications design		
							2.7	Information systems (to support data driven decision making)		
					3	Data Management	3.1	General principles and concepts in Data Management and organisation		
							3.2	Data management systems		
							3.3	Data Management and Enterprise data infrastructure		
							3.4	Data Governance		
							3.5	Big Data storage (large scale)		
							3.6	Digital libraries and archives		
					4	Research Methods and Project Management	4.1	Research Methods		
							4.2	Project Management		
					5	Business Analytics	5.1	Business Analytics Foundation		
							5.1	Business Analytics organisation and enterprise management		

Contoh Pengetahuan untuk Profesi Sasaran Berbasis EDSF DS-BoK - Release 2, IABAC. Profes bisa juga dari Peta Okupasi

	Data Scientist		Data Science Architect		DS Application Programmer		Data Analyst
1	Data Analytics (L5)	1	Data Analytics (L4)	1	Data Analytics (L4)	1	Data Analytics (L5)
2	Data Management (L3)	2	Data Management (L3)	2	Data Management (L2)	2	Data Management (L3)
3	Data Engineering (L5)	3	Data Engineering (L5)	3	Data Engineering (L5)	3	Data Engineering (L3)
4	Research Methods and Project Management (L5)	4	Research Methods and Project Management (L3)	4	Research Methods and Project Management (L3)	4	Research Methods and Project Management (L3)
5	Domain Knwoldege/Business Process Management (L3)	5	Domain Knwoldege/Business Process Management (L3)	5	Domain Knwoldege/Business Process Management (L4)	5	Domain Knwoldege/Business Process Management (L4)



11 Knowledge Areas and It's Sub-domain

Knowledge Areas	Sub-Domains
Analysis and Presentation	<ol style="list-style-type: none">1. AP-Foundational considerations – T12. AP-Visualization – T13. AP-User-centered design – T24. AP-Interaction design – T25. AP-Interface design and development – E
Artificial Intelligence	<ol style="list-style-type: none">1. AI-General – T1, T22. AI-Knowledge Representation and Reasoning (Logic-based models) – T2, E3. AI-Knowledge Representation and Reasoning (Probability-based models) – T1, T2, E4. AI-Planning and Search Strategies – T2, E
Big Data Systems	<ol style="list-style-type: none">1. BDS-Problems of Scale – T12. BDS-Big Data Computing Architectures - E3. BDS-Parallel Computing Frameworks - E4. BDS-Distributed Data Storage – T2, E5. BDS-Parallel Programming – T26. BDS-Techniques for Big Data Applications – T27. BDS-Cloud Computing – T28. BDS-Complexity Theory - E9. BDS-Software Support for Big Data Applications – T2

11 Knowledge Areas and It's Sub-domain

Knowledge Areas	Sub-Domains
Computing and Computer Fundamentals	<ol style="list-style-type: none">1. CCF-Basic Computer Architecture – T1, T22. CCF-Storage System Fundamentals – T13. CCF-Operating System Basics – T1, T24. CCF-File Systems – T1, T25. CCF-Networks – T1, T26. CCF-The Web & Web Programming – T1, T27. CCF-Compilers and Interpreters – T1
Data Acquisition, Management, and Governance	<ol style="list-style-type: none">1. DG-Data Acquisition – T1, T22. DG-Information Extraction – T1, T23. DG-Working with Various Types of Data –T24. DG-Data Integration – T15. DG-Data Reduction and Compression – T1, T26. DG-Data Transformation – T17. DG-Data Cleaning – T18. DG-Data Privacy and Security – T1
Data Privacy, Security, Integrity, and Analysis for Security (DPSIA)	<ol style="list-style-type: none">1. DPSIA/DP-Social Responsibility–T1,T2,E2. DPSIA/DP-Cryptography – T1, T23. DPSIA/DP-Information Systems – T1, T2, E4. DPSIA/DP-Communication Protocols – T1, T2

11 Knowledge Areas and It's Sub-domain

Knowledge Areas	Sub-Domains
Data Mining (DM)	<ol style="list-style-type: none">1. DM-Proximity Measurement – T1, T22. DM-Data Preparation – T13. DM-Information Extraction – E4. DM-Cluster Analysis – T1, T25. DM-Classification and Regression – T1, T2, E6. DM-Pattern Mining – T27. DM-Outlier Detection – T28. DM-Time Series Data – E9. DM-Mining Web Data – T210. DM-Information Retrieval – T2
Machine Learning (ML)	<ol style="list-style-type: none">1. ML-General – T1, T2, E2. ML-Supervised Learning – T1, T2, E3. ML-Unsupervised Learning – T1, T2, E4. ML-Mixed Methods – E5. ML-Deep Learning – T1, T2, E

11 Knowledge Areas and It's Sub-domain

Knowledge Areas	Sub-Domains
Professionalism (PR)	<ol style="list-style-type: none">1. PR-Continuing Professional Development – T12. PR-Communication – T13. PR-Teamwork – T14. PR-Economic Considerations – T25. PR-Privacy and Confidentiality – T16. PR-Ethical Considerations – T17. PR-Legal Considerations – T28. PR-Intellectual Property – E9. PR-On Automation – E
Programming, Data Structures, and Algorithms (PDA)	<ol style="list-style-type: none">1. PDA-Algorithmic Thinking & Problem Solving – T1, T22. PDA-Programming – T1, T2, E3. PDA-Data Structures – T1, T2, E4. PDA-Algorithms – T1, T2, E5. PDA-Basic Complexity Analysis – T1, T26. PDA-Numerical Computing – T1, T2
Software Development and Maintenance (SDM)	<ol style="list-style-type: none">1. SDM-Software Design and Development – T1, T2, E2. SDM-Software Testing – T1, T2, E



Informasi Singkat

Data Science *Body of Knowledge* (DS-BoK) 2019

(*EDSF DS-BoK - Release 2, IABAC*)

dan *Learning Outcome*

Achmad Benny Mutiara

Dekan Fakultas Ilmu Komputer dan Teknologi Informasi, Universitas Gunadarma

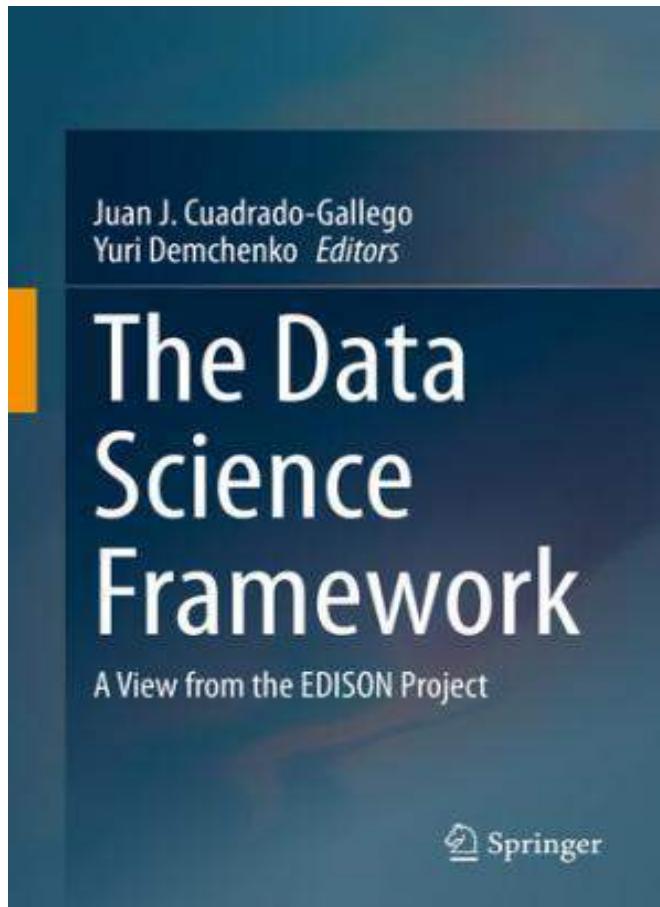
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2022

Akronim

- IABAC : Internasional Association of Business Analytics Certifications
- EDSF: Edison Data Science Framework
- EDISON: Education for Data Intensive Science to Open New science frontiers
- CF-DS: Data Science Competence Framework

Rujukan-Rujukan Utama



Details CP (LO) Profil di atas: (berikut kuliah-2 terkait)
Data Science Model Curriculum (MC-DS) pada dokumen berikut:
EDISON Data Science Framework:
Part 3. Data Science Model Curriculum (MC-DS) ***Release 2***

Rujukan-Rujukan Utama



IABAC International Association of
Business Analytics Certification

Data Science Body of Knowledge

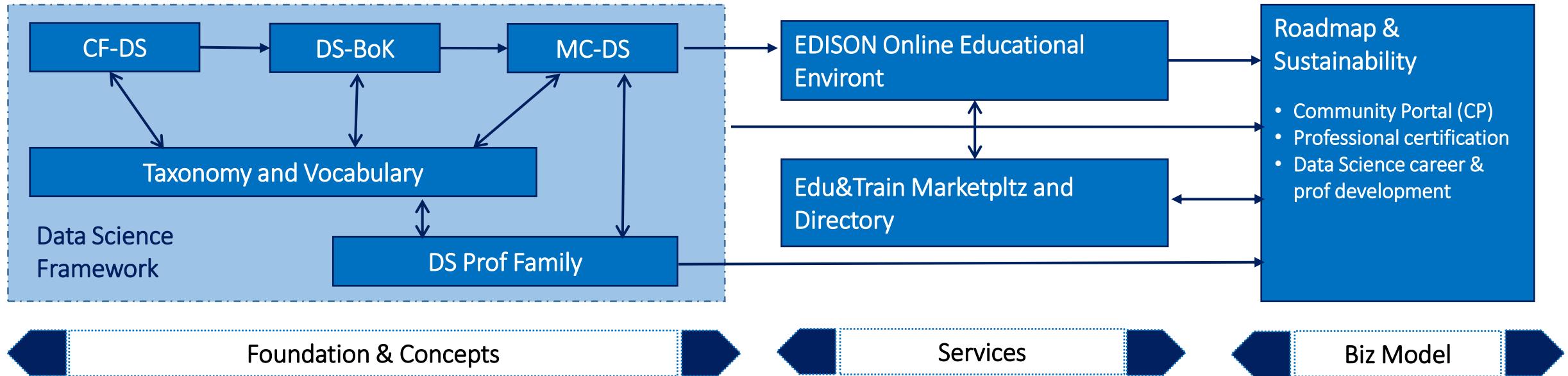
EDSF DS-BoK - Release 2

www.iabac.org

Data Science Body of Knowledge (DS-BoK)
EDSF DS-BoK - Release 2
EDISON DATA SCIENCE FRAMEWORK (EDSF)

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EDISON Data Science Framework (EDSF): Menciptakan Fondasi untuk *Data Science* Profession



EDISON Framework components

- CF-DS – Data Science Competence Framework
- DS-BoK – Data Science Body of Knowledge
- MC-DS – Data Science Model Curriculum
- DSP - Data Science Professions family and professional competence profiles
- EOEE - EDISON Online Education Environment

Other components and services

- EOEE - EDISON Online Education Environment
- Education and Training Marketplace and Resources Directory
- Data Science professional certification and training
- Community Portal (CP)

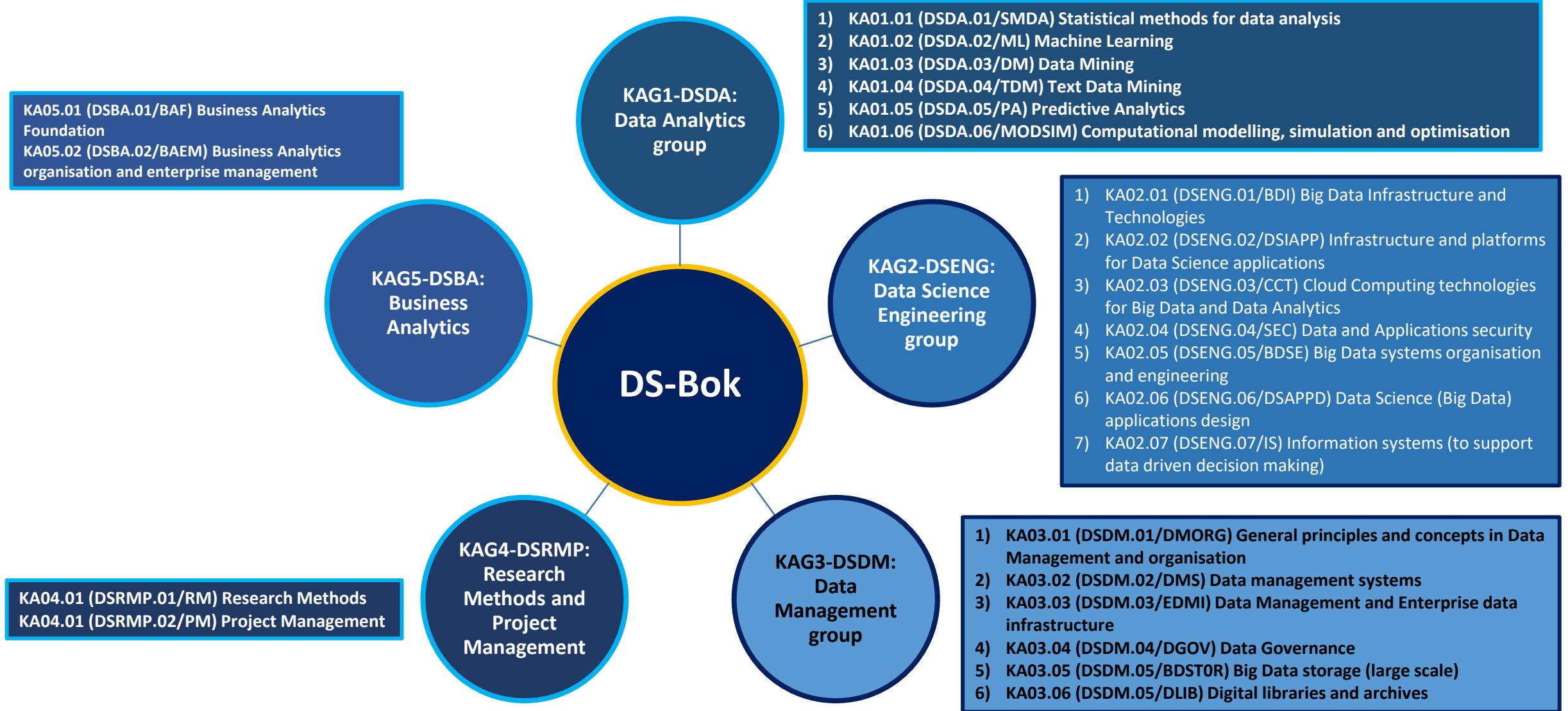
Definisi: Data Science Body of Knowledge (DS-BoK)

- Definisi Kerangka Pengetahuan (Body of Knowledge) Sains Data memberikan dasar untuk menentukan Kurikulum Model Sains Data dan selanjutnya untuk sertifikasi profesional Ilmu Data.
- DS-BoK yang disajikan mendefinisikan lima Grup Area Pengetahuan (KAG) yang ditautkan ke grup kompetensi yang teridentifikasi:
 - KGA1-DSDA Data Analytics;
 - KGA2-DSENG Data Science Engineering,
 - KGA3-DSDM Data Management,
 - KGA4-DSRMP Research Methods and Project Management; dan
 - KGA5-DSBA Business Analytics;yang mewakili salah satu area domain paling aktif yang diberdayakan oleh Sains Data.
- Pendefinisian kelompok pengetahuan domain (domain knowledge groups) **KAG*-DSDK** baik untuk sains dan bisnis akan menjadi subyek untuk pengembangan lebih lanjut dalam kerjasama yang erat dengan para spesialis domain.

Pendekatan dan Struktur Umum DS-BoK

- DS-BoK yang dimaksud dapat digunakan sebagai dasar untuk mendefinisikan kurikulum terkait Sains Data, kuliah, metode pengajaran, materi pendidikan / kuliah, dan praktik yang diperlukan untuk program pascasarjana dan sarjana serta kuliah pelatihan profesional.
- DS BoK juga dimaksudkan untuk digunakan dalam menentukan program sertifikasi dan pertanyaan ujian sertifikasi.
- Sementara CF-DS (terdiri dari kompetensi, ketrampilan, dan pengetahuan) dapat digunakan untuk menentukan profil pekerjaan (dan konten iklan pekerjaan yang sesuai), DS-BoK dapat memberikan dasar untuk pertanyaan wawancara dan evaluasi pengetahuan kandidat dan ketrampilan terkait.
- Mengikuti definisi kelompok kompetensi CF-DS, DS-BoK harus berisi kelompok Area Pengetahuan (KAG) berikut:
 - 1) KAG1-DSDA: Data Analytics group termasuk Machine Learning, statistical methods, dan Business Analytics
 - 2) KAG2-DSENG: Data Science Engineering group termasuk Software dan infrastructure engineering
 - 3) KAG3-DSDM: Data Management group termasuk data curation, preservation dan data infrastructure
 - 4) KAG4-DSRMP: Research Methods and Project Management
 - 5) KAG5-DSBA: Business Analytics

Knowledge Area groups (KAG)



Tingkat Penguasaan dan Capaian Pembelajaran

Table 1 Tingkat pengetahuan untuk capaian pembelajaran dalam kurikulum model Sains Data (MC-DS)

Tingkat	Kata Kerja Aksi
Kebiasaan (Familiarity)	Choose, Classify, Collect, Compare, Configure, Contrast, Define, Demonstrate, Describe, Execute, Explain, Find, Identify, Illustrate, Label, List, Match, Name, Omit, Operate, Outline, Recall, Rephrase, Show, Summarize, Tell, Translate
Penggunaan (Usage)	Apply, Analyze, Build, Construct, Develop, Examine, Experiment with, Identify, Infer, Inspect, Model, Motivate, Organize, Select, Simplify, Solve, Survey, Test for, Visualize
Penilaian (Assessment)	Adapt, Assess, Change, Combine, Compile, Compose, Conclude, Criticize, Create, Decide, Deduct, Defend, Design, Discuss, Determine, Disprove, Evaluate, Imagine, Improve, Influence, Invent, Judge, Justify, Optimize, Plan, Predict, Prioritize, Prove, Rate, Recommend, Solve

Definisi Capaian Pembelajaran berdasarkan CF-DS

Tabel 2 Hasil pembelajaran ditentukan untuk kompetensi CF-DS dan tingkat penguasaan / kemahiran yang berbeda

LO.ID	Data Science Competence	LO menurut tingkat Pengetahuan (sesuai dengan ACM CSC 2013) dan kata kerja kunci		
		Familiarity	Usage	Assessment
Data Science Data Analytics				
LO1-DA	DSDA-DA - Use appropriate statistical techniques and predictive analytics on available data to deliver insights and discover new relations.	Choose appropriate existing analytical method and operate existing tools to do specified data analysis. Present data in the required form.	Develop data analysis application for specific data sets and tasks or processes. Identify necessary methods and use them in combination if necessary. Identify relations and provide consistent reports and visualizations.	Create formal model for the specific organizational tasks and processes and use it to discover hidden relations, propose optimization and improvements. Develop new models and methods if necessary. Recommend and influence organizational improvement based on continuous data analysis
LO1.01	DSDA01 - Use predictive analytics to analyze big data and discover new relations.	Choose and execute existing predictive analytics tools.	Identify existing requirements and develop predictive analysis tools	Design and evaluate predictive analysis tools to discover new relations.
LO1.02	DSDA02 - Use appropriate statistical techniques on available data to deliver insights.	Choose and execute standard methods from existing statistical libraries to provide overview	Select most appropriate statistical techniques and model available data to deliver insights.	Assess and optimize organization processes using statistical techniques.

Definisi Capaian Pembelajaran berdasarkan CF-DS

LO.ID	Data Science Competence	LO menurut tingkat Pengetahuan (sesuai dengan ACM CSC 2013) dan kata kerja kunci		
		Familiarity	Usage	Assessment
LO1.03	DSDA03 - Develop specialized analytics to enable agile decision making	Define data elements necessary to develop specified data analytics.	Develop specialized analytics to enable decision-making.	Design specialized analytics to improve decision-making
LO1.04	DSDA04 - Research and analyze complex data sets, combine different sources and types of data to improve analysis.	Operate tools for complex data handling.	Analyze available data sources and develop tool that work with complex datasets.	Assess, adapt, and combine data sources to improve analytics
LO1.05	DSDA05 - Use different data analytics platforms to process complex data.	Name and operate major data analytic platforms.	Examine existing platforms and select most appropriate platform w.r.t. technical specification.	Evaluate and recommend data analytics platforms w.r.t organizational strategy.
LO1.06	DSDA06 - Visualise complex and variable data.	Choose and execute standard visualization.	Build visualizations for complex and variable data.	Create and optimize visualizations to influence executive decisions

Definisi Capaian Pembelajaran berdasarkan CF-DS

LO.ID	Data Science Competence	LO menurut tingkat Pengetahuan (sesuai dengan ACM CSC 2013) dan kata kerja kunci		
		Familiarity	Usage	Assessment
Data Science Data Management				
LO2-DM	DSDM-DM - Develop and implement data management strategy for data collection, storage, preservation, and availability for further processing	Execute data strategy in a form of Data Management Plan and illustrate how available software can help to promote data quality and accessibility	Develop components of data strategy and methods that improve quality, accessibility and publications of data.	Create Data Management Plan aligned with the organizational needs, evaluate IPR and ethical issues.
LO2.01	DSDM01 - Develop and implement data strategy, in particular, in a form of Data Management Plan (DMP).	Explain and execute data strategy in a form of Data Management Plan.	Develop components of data strategy in a form of Data Management Plan. d with organizational needs.	Assess various data strategies and create strategy, in a form of Data Management Plan, aligned with organizational needs.
LO2.02	DSDM02 - Develop and implement relevant data models, including metadata.	Operate data models including metadata.	Experiment with data models and model relevant metadata.	Evaluate and design data models, including metadata.
LO2.03	DSDM03 - Collect and integrate different data source and provide them for further analysis.	Collect different data sources.	Survey and visualize connection between different data sources.	Compose different data sources to enable further analysis.
LO2.04	DSDM04 - Develop and maintain a historical data repository of analysis results (data provenance).	Operate a historical data repository.	Improve or design a historical data repository.	Improve or design a historical data repository.

Definisi Capaian Pembelajaran berdasarkan CF-DS

LO.ID	Data Science Competence	LO menurut tingkat Pengetahuan (sesuai dengan ACM CSC 2013) dan kata kerja kunci		
		Familiarity	Usage	Assessment
LO2.05	DSDM05 - Ensure data quality, accessibility, publications (data curation).	Illustrate how available software can help to promote data quality, accessibility and publications.	Develop methods that improve quality, accessibility and publications of data.	Improve quality, accessibility and publications of data.
LO2.06	DSDM06 - Manage IPR and ethical issues in data management.	Configure data management software to manage IPR and ethical issues.	Identify IPR and ethical issues in data repository.	Evaluate IPR and ethical issues in data repository.

Definisi Capaian Pembelajaran berdasarkan CF-DS

LO.ID	Data Science Competence	LO menurut tingkat Pengetahuan (sesuai dengan ACM CSC 2013) dan kata kerja kunci		
		Familiarity	Usage	Assessment
Data Science Engineering				
LO3-ENG	DS-ENG - Use engineering principles to research, design, develop and implement new instruments and applications for data collection, analysis and management.	Identify and operate instruments and applications for data collection, analysis and management	Model problems and develop new instruments and applications for data collection, analysis and management following established engineering principles	Evaluate instruments and applications to optimize data collection, analysis and management.
LO3.01	DSENG01 - Use engineering principles to research, design, prototype data analytics applications, or develop structures, instruments, machines, experiments, processes, systems	Choose potential technologies to develop, structure, instrument, machines, experiments, processes, and systems.	Model data analytics application to better develop suitable instruments, machines, experiments, processes, and systems.	Create innovative solution to research and design data analytics
LO3.02	DSENG02 - Develop and apply computational solutions to domain related problems using wide range of data analytics platforms.	Name computational solution and identify potential data analytics platform	Apply existing computational solutions to data analytic platform.	Adapt and optimize existing computational solutions to better fit to a given data analytics platform.
LO3.03	DSENG03 - Develops specialized data analysis tools to support executive decision making.	Identify a set of potential data analytics tools to fit specification.	Survey various specialized data analytics tools and identify the best option.	Evaluate and recommend optimal data analytics tools to influence decision making.

Definisi Capaian Pembelajaran berdasarkan CF-DS

LO.ID	Data Science Competence	LO menurut tingkat Pengetahuan (sesuai dengan ACM CSC 2013) dan kata kerja kunci		
		Familiarity	Usage	Assessment
LO3.04	DSENG04 - Design, build, operate database technologies.	Find possible database solutions including both relational and non-relational databases.	Model the problem to apply database technology.	Predict the difference in term of performance between relational and non-relational databases and recommend a solution.
LO3.05	DSENG05 - Develop solutions for secure and reliable data access.	Identify security issues related to reliable data access.	Analyze security threats and solve them using known techniques.	Evaluate security threats and recommend adequate solutions.
LO3.06	DSENG06 - Prototype new data analytics applications.	Define technical requirements for new data analytics application for a given high-level design.	Apply existing techniques to develop new data analytics applications.	Combine several techniques and optimize them to design new data analytic applications.

Definisi Capaian Pembelajaran berdasarkan CF-DS

LO.ID	Data Science Competence	LO menurut tingkat Pengetahuan (sesuai dengan ACM CSC 2013) dan kata kerja kunci		
		Familiarity	Usage	Assessment
Data Science Research Methods				
LO4-RM	DS-RM - Create new understandings and capabilities by using the scientific method (hypothesis, test/artefact, evaluation) or similar engineering methods to discover new approaches to create new knowledge and achieve research or organizational goals	Match elements of scientific or similar method and identify appropriate actions for organizational strategy to create new capabilities.	Apply scientific or similar method and develop action plans to translate organizational strategies to create new capabilities.	Evaluate methodologies to optimize the development of organizational objectives.
LO4.01	DSRM01 - Create new understandings and capabilities by using the scientific method (hypothesis, test, and evaluation) or similar engineering research and development methods.	Match elements of scientific or similar method to a given problem	Apply scientific method to create a new understandings and capabilities.	Evaluate various methods and predict which method can optimize creation of new understandings and capabilities.
LO4.02	DSRM02 - Direct systematic study toward a fuller knowledge or understanding of the observable facts, and discovers new approaches to achieve research or organizational goals.	Choose observable facts from an existing study for a better understanding.	Apply systematic study toward a fuller knowledge or understanding of the observable facts.	Combine several methods to discover new approaches to achieve organizational goals.
LO4.03	DSRM03 - Undertakes creative work, making systematic use of investigation or experimentation, to discover or revise knowledge of reality, and uses this knowledge to devise new applications	Show creativity under guidance of a senior staff in discovering and revising knowledge.	Develop creative solutions using systematic investigation or experimentation to revise and discover knowledge.	Adapt common systematic investigation to design and plan creative work to discover or revise knowledge

Definisi Capaian Pembelajaran berdasarkan CF-DS

LO.ID	Data Science Competence	LO menurut tingkat Pengetahuan (sesuai dengan ACM CSC 2013) dan kata kerja kunci		
		Familiarity	Usage	Assessment
LO4.04	DSRM04 - Ability to translate strategies into action plans and follow through to completion.	Identify appropriate actions for a given strategies.	Develop actions and action plan to translate strategies.	Recommend effective action plans to translate strategies.
LO4.05	DSRM05 - Contribute to and influence the development of organizational objectives.	Identify possible points which influence development of organization objectives	Identify critical points which influence development of organizational objective	Recommend strategies that optimize the development of organizational objective
LO4.06	DSRM06 - Apply ingenuity to complex problems, develop innovative ideas	Illustrate outstanding ideas to solve complex problems.	Identify non-standard solutions to solve complex problems.	Recommend cost effective solution to a complex problem.

Definisi Capaian Pembelajaran berdasarkan CF-DS

LO.ID	Data Science Competence	LO menurut tingkat Pengetahuan (sesuai dengan ACM CSC 2013) dan kata kerja kunci		
		Familiarity	Usage	Assessment
Business Analytics/Business Process Management				
LO5-BA	Use domain knowledge (scientific or business) to develop relevant data analytics applications; adopt general Data Science methods to domain specific data types and presentations, data and process models, organisational roles and relations	Match elements of a mathematical framework to a given business problem and operate data support services for other organizational roles.	Model business problems into an abstract mathematical framework and identify critical points which influence development of organizational objectives.	Evaluate various methods to predict which method can optimize solving business problems and recommend strategies that optimize the development of organizational objectives.
LO5.01	DSBA01 Analyse information needs, assess existing data and suggest/identify new data required for specific business context to achieve organizational goal, including using social network and open data sources	Match elements of a mathematical framework to a given business problem.	Model an unstructured business problem into an abstract mathematical framework.	Evaluate various methods and predict which method can optimize solving business problems.
LO5.02	DSBA02 Operationalise fuzzy concepts to enable key performance indicators measurement to validate the business analysis, identify and assess potential challenges	Match data to specification of services	Analyze services to develop data specification..	Assess and improve use of data in services.
LO5.03	DSBA03 Deliver business focused analysis using appropriate BA/BI methods and tools, identify business impact from trends; make business case as a result of organisational data analysis and identified trends	Identify appropriate actions for management and organizational decisions.	Identify critical points which influence development of organizational objectives.	Recommend strategies that optimize the development of organizational objectives.

Definisi Capaian Pembelajaran berdasarkan CF-DS

LO.ID	Data Science Competence	LO menurut tingkat Pengetahuan (sesuai dengan ACM CSC 2013) dan kata kerja kunci		
		Familiarity	Usage	Assessment
LO5.04	DSBA04 Analyse opportunity and suggest use of historical data available at organisation for organizational processes optimization	Operate data support services for other organizational roles.	Develop data support services for other organizational roles.	Optimize data support services for other organizational roles.
LO5.05	DSBA05 Analyse customer relations data to optimise/improve interacting with the specific user groups or in the specific business sectors	Summarize customer data.	Survey and visualize customer data.	Recommend actions based on data analysis to improve customer relations.
LO5.06	DSBA06 Analyse multiple data sources for marketing purposes; identify effective marketing actions	Access and use external open data and social network data.	Identify data that bring value to used analytics for marketing. Use cloud based solutions.	Suggest new marketing models based on existing and external data.

Thank you



Gambar Umum Kurikulum SK: Catatan CC2020 + CE2016, dan Bok

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Bagian 1

CATATAN CC2020 & CE2016

Apa itu Sistem Komputer

- **Sistem Komputer (SK)** menyatukan **komputasi** dan **teknik elektro** sedemikian mencakup:
 - ilmu pengetahuan dan teknologi desain,
 - konstruksi, implementasi, dan pemeliharaan komponen perangkat lunak dan perangkat keras dari sistem komputasi modern, peralatan yang dikendalikan komputer, dan jaringan perangkat cerdas.
- **SK** adalah disiplin komputasi yang secara eksplisit berfokus pada pengembangan perangkat keras dan **antarmuka perangkat lunak** sebagai elemen **tertanam** perangkat keras dari sistem komputasi.

Lulusan SK

- Kemampuan **Lulusan SK** mengintegrasikan bakat teknik elektro, rekayasa perangkat lunak, dan ilmu komputer dengan penekanan berat pada matematika yang diperlukan sebagai dasar.
- **Lulusan SK** harus memiliki kemampuan mendesain komputer, mendesain sistem berbasis komputer, dan mendesain jaringan dengan spesifikasi tambahan yang kebutuhan desainnya **melebihi** konfigurasi dan perakitan sederhana.
- **Lulusan SK** harus memiliki pengetahuan yang luas dalam **matematika** dan ilmu teknik dengan persiapan untuk praktik profesional atau pekerjaan lulusan di bidang teknik

Lulusan SK

- Disiplin **SK** memungkinkan lulusan untuk menganalisis dan merancang rangkaian, mengelola desain komponen perangkat keras komputer, dan mengembangkan solusi perangkat keras jaringan.
 - Bagi mahasiswa yang tertarik untuk mendapatkan pengalaman dalam mengintegrasikan kemampuan komputasi secara langsung dengan perangkat keras komputasi, **SK** bisa menjadi pilihan program gelar yang tepat.
 - **SK** juga menyediakan persiapan yang sangat baik untuk desain dan pengembangan teknologi modern yang mengintegrasikan erat dunia fisik dengan dunia buatan.

Kurikulum: MK Berpraktikum dan Praktikum

- Kurikulum memuat MK-MK berpraktikum dan Praktikum
- Karena terkait Lab-Lab yang disarankan pada **CE2016**

Laboratorium SK

- Table 4.1 menggambarkan rekomendasi komite pengarah tentang jenis laboratorium yang harus dialami oleh mahasiswa yang belajar teknik komputer. Beberapa laboratorium melibatkan praktik yang **harus (wajib)** atau **sebaiknya dilakukan** oleh semua mahasiswa teknik komputer. Laboratorium yang ditunjukkan oleh “●●●●” mengacu pada **pengalaman berbeda/spesifik** yang harus dimiliki setiap insinyur komputer, sedangkan yang ditunjukkan oleh “●●” mengacu pada pengalaman **yang sebaiknya dimiliki** setiap insinyur komputer.
- Ketersediaan laboratorium tambahan akan tergantung pada kebutuhan, tujuan, dan sumber daya program lokal;
- Table 4.1 mengilustrasikan beberapa jenis laboratorium yang umum.

Table 4.1: Types of computer engineering laboratories

Laboratory Type	Must	Should	Supplemental
Circuits and Electronics	●●●●		
Computer Architecture Design			●
Digital Signal Processing			●
Digital Logic and System Design	●●●●		
Embedded Systems	●●●●		
Introduction to Engineering			●
Networking		●●	
Software Design		●●	
Senior Project Design	●●●●		

Laboratorium SK

- Table 4.2 menunjukkan opsi laboratorium tambahan yang dapat dipertimbangkan oleh program.

Table 4.2: Suggested Additional Computer Engineering Laboratories

Audio Engineering	Microwave Measurements
Computers in Manufacturing	Operating Systems
Electrical Energy Systems	Robotics
Graphics	Specialized Electronics Lab
Mechatronics	Teaching Enhancement
	Telecommunications

Pertimbangan Perangkat Lunak

- **Tools dan paket perangkat lunak** yang terkait dengan teknik komputer akan bervariasi berdasarkan filosofi dan kebutuhan masing-masing program.
- **Table 4.3** menyarankan beberapa perangkat lunak yang dapat digunakan di semua alat dalam pengaturan laboratorium tertentu

Table 4.3: Suggestions for possible software applications

Design modeling and simulation <ul style="list-style-type: none">• Circuit-level (e.g., SPICE)• Gate-level (schematic entry)• Digital systems (e.g., VHDL, Verilog)• Analog/mixed-signal circuits (e.g., VHDL-AMS, Verilog-AMS)• System-level design (e.g., System Verilog, System C) Digital hardware prototyping <ul style="list-style-type: none">• FPGA/CPLD development suite• Design file entry and management• Component/IP library support• Device programming• Interactive debugging Microcontroller system design <ul style="list-style-type: none">• Integrated development environment (IDE)<ul style="list-style-type: none">▪ Design entry/management▪ Library support• Compilers, assemblers, linkers• Processor simulators/emulators• Device programming• In-circuit test/debug Mathematics packages <ul style="list-style-type: none">• Problem solving• Data analysis• Modeling and simulation	Software development <ul style="list-style-type: none">• Integrated development environment (IDE)<ul style="list-style-type: none">▪ Design entry and management▪ Library support• Compilers (e.g., C, C++, C#, Java, Python)• Operating system support• Source-level debugging• Platform support (e.g., smartphone, tablet) Integrated circuit/ASIC design <ul style="list-style-type: none">• Design capture and simulation• Synthesis• Physical layout<ul style="list-style-type: none">▪ graphical layout editor▪ automated layout• Design verification (design rules, layout vs. schematic, parameter extraction)• Design for testability, automatic test pattern generation Printed circuit board (PCB) design Computer-aided design and modeling (CAD tools) Laboratory automation and instrumentation (e.g., IntuiLink or LabVIEW software)	General computing/productivity <ul style="list-style-type: none">• Web browser• Email• Office suite• PDF reader/editor• Illustration/photo viewer/editor• Multimedia players/editors• File compression/decompression• File transfer (FTP, SCP, SFTP)• Terminal emulator, remote login, secure shell, X Window client System engineering tools <ul style="list-style-type: none">• Project management (e.g., GANTT or PERT charts)• Requirements and specifications management (e.g., UML tools) Other tools <ul style="list-style-type: none">• Robotics software development• Semiconductor device and process modeling (e.g., TCAD)• Microwave, RF and other high-speed/high-frequency design• Electromagnetic field simulation• MEMS design
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Bagian 2

BoK CC2020 + CE2016

Model Arsitektur Kurikulum Sistem Komputer Berdasarkan CC 2020 dan CE 2016

Bobot	Pengetahuan Wajib Setiap Prodi INFOKOM							
	1	Social Issues and Professional Practice	6	Systems Analysis & Design	11	Security Technology and Implementation	16	Data Structures, Algorithms & Complexity
	2	Security Policy and Management	7	Data and Information Management	12	Software Quality, Verification and Validation	17	Programming Languages
	3	Project Management	8	Virtual Systems and Services	13	Software Modeling and Analysis	18	Programming Fundamentals
	4	User Experience Design	9	Parallel and Distributed Computing	14	Software Design	19	Computing Systems Fundamentals
	5	Security Issues and Principles	10	Computer Networks	15	Operating Systems	20	Architecture and Organization
Pengetahuan Inti per Prodi Infokom								
Sistem Komputer CC 2020				Sistem Komputer CE 2016			Sistem Komputer CC2020+CE2016	
	1	Internet of Things		1	Computing Algorithms (Ada di CC 2020)		1	Adv. Computer Networks
	2	Parallel and Distributed Computing		2	Computer Networks (Ada di CC 2020)		2	Adv. Parallel and Distributed Computing
	3	Embedded Systems		3	Embedded Systems (Ada di CC 2020)		3	Embedded Systems
	4	Computing Systems Fundamentals		4	Information Security (Ada di CC 2020)		4	Computing Systems Fundamentals
	5	Architecture and Organization		5	Computer Architecture and Organization (Ada di CC 2020)		5	Computer Architecture and Organization
	6	Digital Design		6	Digital Design (Ada di CC 2020)		6	Digital Design
	7	Circuits and Electronics		7	Circuits and Electronics (Ada di CC 2020)		7	Circuits and Electronics
	8	Signal Processing		8	Signal Processing (Ada CC 2020)		8	Signal Processing
				9	Systems and Project Engineering		9	Systems and Project Engineering
				10	Systems Resource Management		10	Systems Resource Management
				11	Software Design (Ada di CC 2020)		11	Software Design for Hardware Device
				12	Preparation for Professional Practice (Ada di CC 2020)		12	Information Security
Contoh Pengetahuan (Kompetensi di CE 2016 dan Peta Okupasi) untuk Profesi Sasaran								
Computer Engineer		Network Security Analyst		System Administrator		Network Administrator		
1	KA CC 2020 dan CE 2016	1	Adv. Information Security	1	Network and Application Services	1	Adv. Computer Network	
2		2	Adv. Network Security	2	Adv. Server System	2	Adv. Network Security	
3				3	Server System Security	3	Testing and Monitoring Network System Performance	
4						4	Network System Maintenance	
5								

BoK of CE Curricula based on CC-2020 and CE-2016, and Sample Profession Knowledge





Gambar Umum Kurikulum Teknologi Informasi: Catatan CC2020 + IT2017, dan BoK

Achmad Benny Mutiara

Dekan Fakultas Ilmu Komputer dan Teknologi Informasi, Universitas Gunadarma

SEKJEN-APTIKOM

2022

Bagian 1

CATATAN CC2020 & IT2017

Apa itu **Teknologi Informasi** ?

- **Teknologi Informasi** : Studi tentang pendekatan sistemik untuk memilih, mengembangkan, menerapkan, mengintegrasikan, dan mengelola ***teknologi komputasi yang aman*** untuk memungkinkan pengguna mencapai tujuan pribadi, organisasi, dan sosial mereka (**IT2017**)
- **Teknologi Informasi**: menekankan, membangun dan memelihara kemampuan infrastruktur komputasi organisasi dan dukungan pengguna (**CC2020**)

Computing Interrelationships

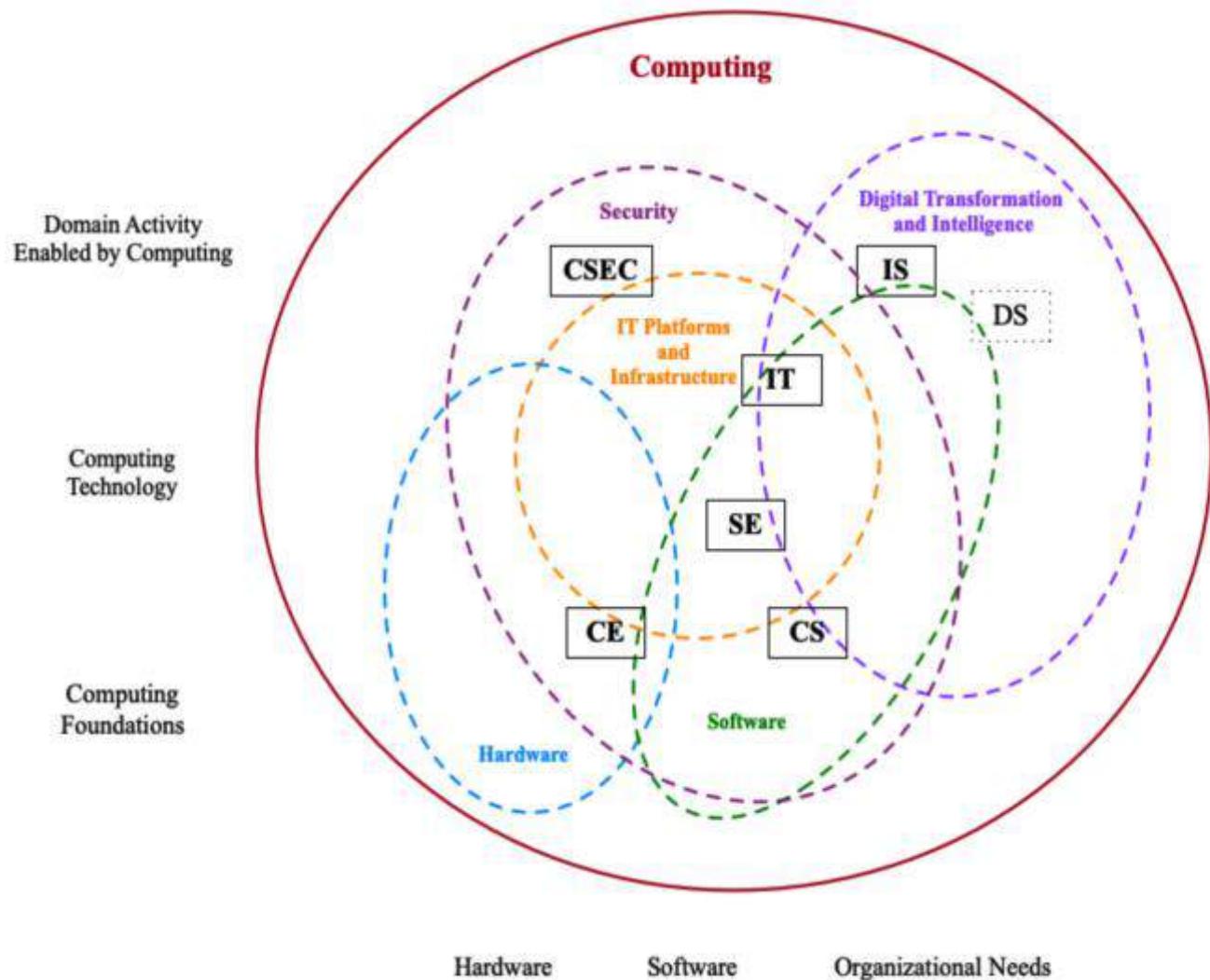


Figure 2.2. A contemporary view of the landscape of computing education

Legend: Curricular reports: CE=computer engineering; CS=computer science; CSEC=cybersecurity; IS=information systems; IT=information technology; SE=software engineering; DS=data science (under development).

Computing Interrelationships

Gambar 2.2 mengilustrasikan:

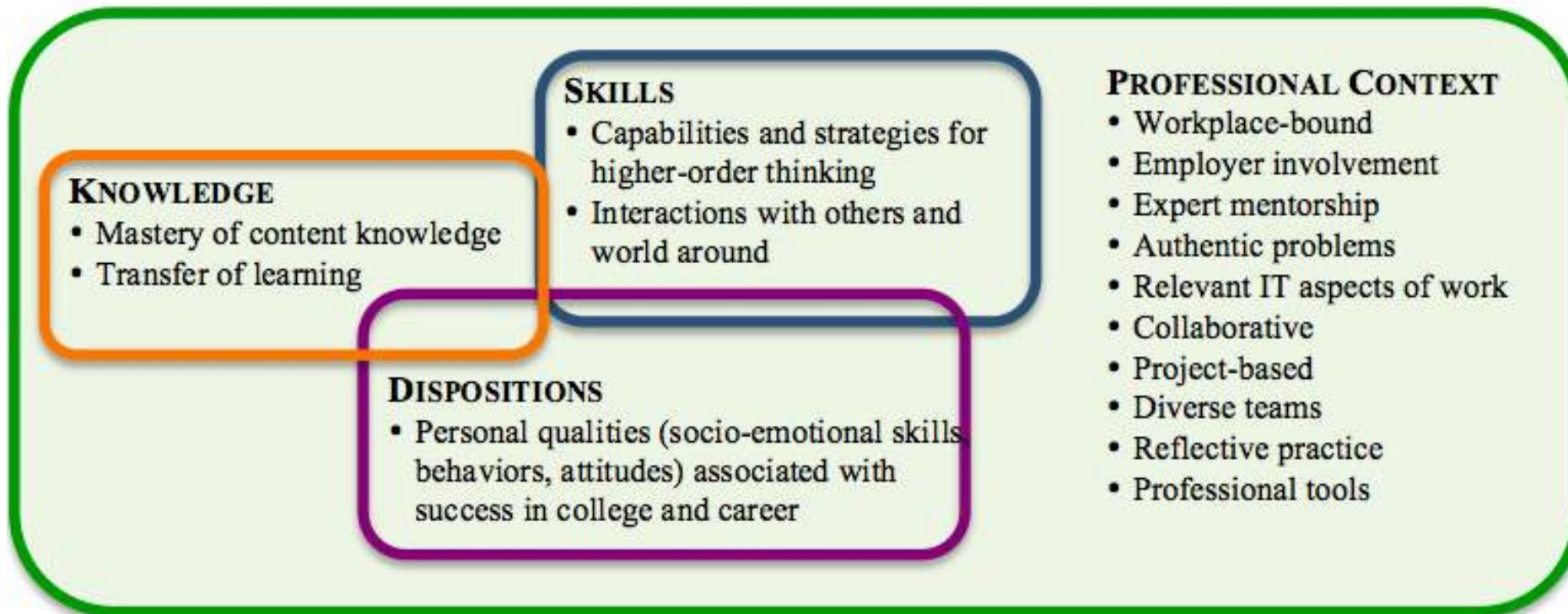
- tiga tingkat (**foundations**, **technology**, **domain activity**) dari “**computing**”
- terkait dengan perangkat keras, perangkat lunak, dan kebutuhan organisasi organizational

Daerah internal bertitik-titik karena tidak mutlak.

- **Information technology platforms and infrastructure** men-**capture** integrasi perangkat keras dan perangkat lunak ke dalam solusi teknologi yang memungkinkan solusi berbasis komputasi yang memiliki kemampuan terkait dengan penyimpanan data, pemrosesan, kecerdasan buatan, dan visualisasi.
 - Teknik komputer, ilmu komputer, dan rekayasa perangkat lunak menyediakan komponen yang diperlukan agar kemampuan teknologi komputasi ini ada.
 - **Teknologi informasi** berfokus pada membuat dan menjaganya tersedia untuk pengguna individu dan organisasi.
- **The area of digital intelligence and transformation** mencakup penangkapan (capture), pengelolaan, dan analisis data yang memungkinkan individu, organisasi, dan masyarakat untuk melakukan aktivitas mereka dengan cara membantu mencapai tujuan mereka dengan lebih baik.
 - Bidang sistem informasi (dan sains data) memungkinkan **digital intelligence and transformation**.
- **Security** diperlukan dan meresap/menembu seluruh ruang komputasi.
- Ini adalah proses di mana organisasi berubah menggunakan kemampuan komputasi.

IT Competencies

IT COMPETENCIES = (KNOWLEDGE + SKILLS + DISPOSITIONS) IN CONTEXT



IT Competency Domains

11 Essential Domains (40%)

- ITE-CSP Cybersecurity Principles (6%)
- ITE-GPP Global Professional Practice (3%)
- ITE-IMA Information Management (6%)
- ITE-IST Integrated Systems Technology (3%)
- ITE-NET Networking (5%)
- ITE-PFT Platform Technologies (1%)
- ITE-SPA System Paradigms (6%)
- ITE-SWF Software Fundamentals (4%)
- TTE-UXD User Experience Design (3%)
- ITE-WMS Web and Mobile Systems (3%)

9 Supplemental Domains (20%)

- ITE-ANE Applied Networks (4%)
- ITE-CCO Cloud Computing (4%)
- ITE-CEC Cybersecurity Emerging Challenges (4%)
- ITE-DSA Data Scalability and Analytics (4%)
- ITE-IOT Internet of Things (4%)
- ITE-MAP Mobile Applications (3%)
- ITE-SDM Software Development Management (2%)
- ITE-SRE Social Responsibility (2%)
- ITE-VSS Virtual Systems and Services (4%)

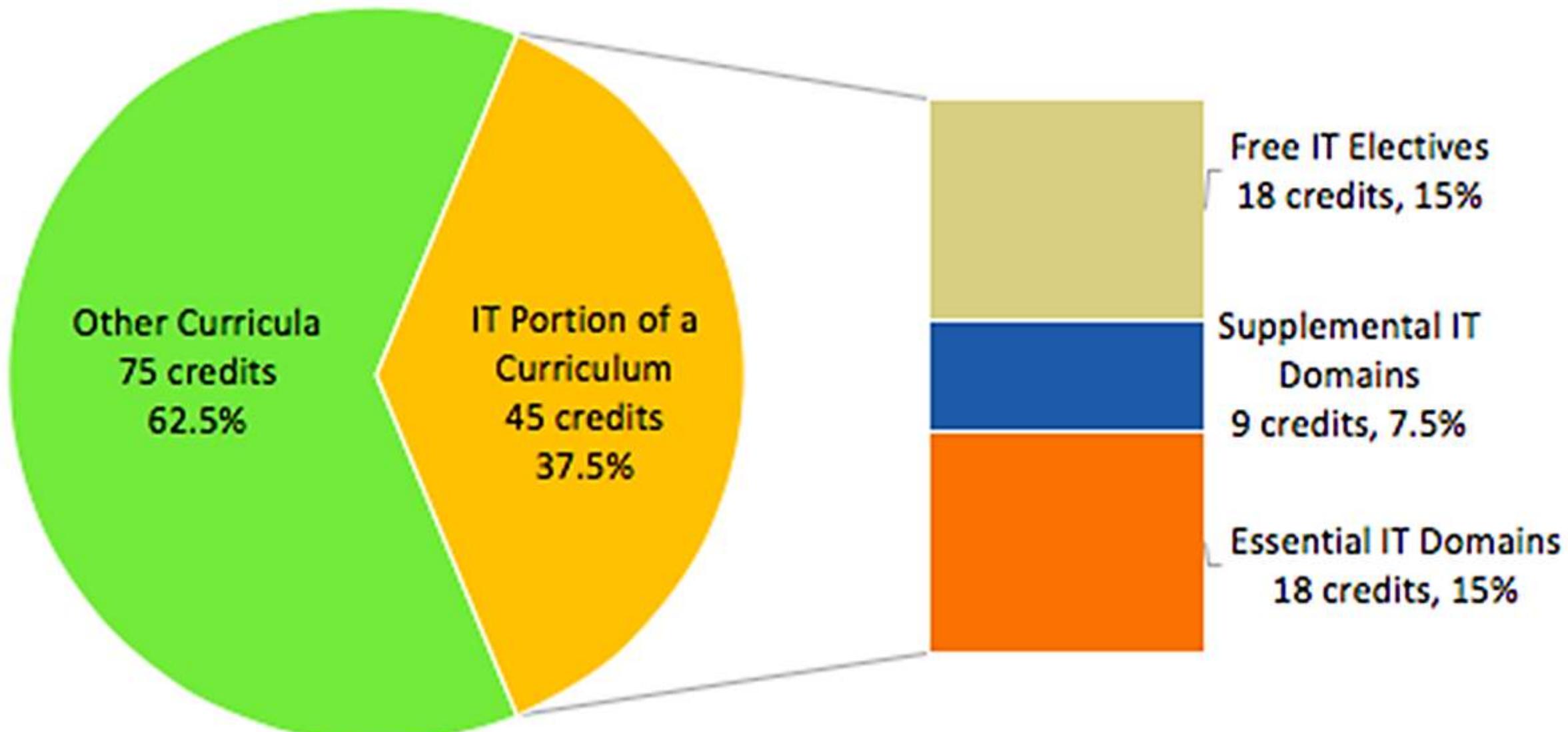
Free IT Electives (40%)

Additional IT competencies

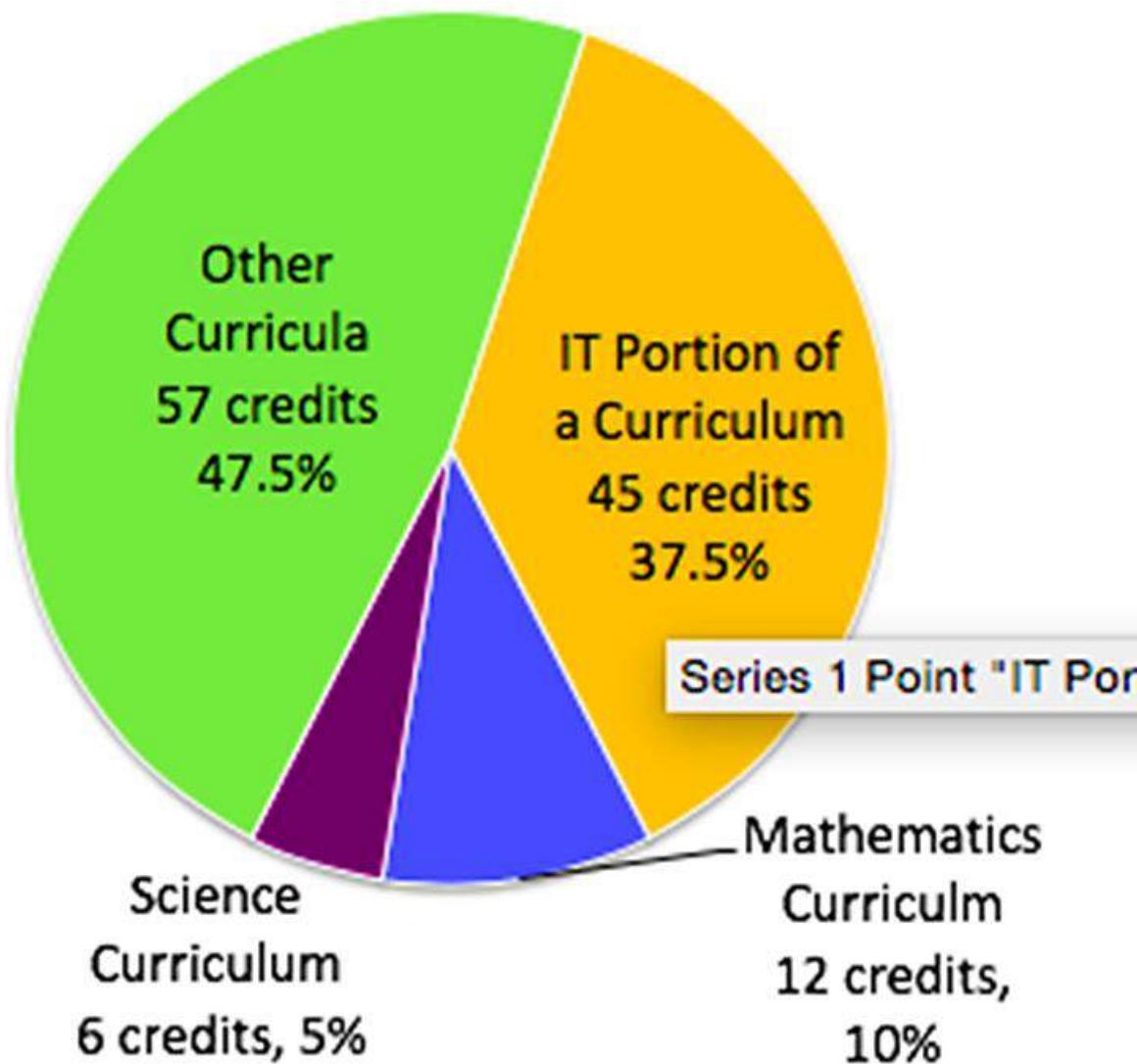
IT Curricular Framework

IT Domains	Essential Percent	Supplemental Percent
Essential Only		
Information Management	6%	0
Integrated Systems Technology	3%	0
Platform Technologies	1%	0
System Paradigms	6%	0
User Experience Design	3%	0
<i>Subtotal:</i>	19%	0
Essential + Supplemental		
Cybersecurity Principles / Cybersecurity Emerging Challenges	6%	4%
Global Professional Practice / Social Responsibility	3%	2%
Networking / Applied Networks	5%	4%
Software Fundamentals / Software Development and Management	4%	2%
Web and Mobile Systems / Mobile Applications	3%	3%
<i>Subtotal:</i>	21%	
Supplemental Only		
Cloud Computing	0	4%
Data Scalability and Analytics	0	4%
Internet of Things	0	4%
Virtual Systems and Services	0	4%
<i>Subtotal:</i>	0	
IT2017 TOTAL:	40.0%	

Example of the minimal IT portion of a curriculum of an undergraduate IT degree program of 120 credits



Example of the IT, mathematics, and science portions of a curriculum of an undergraduate IT degree program of 120 credits



Example of IT Domain Cluster

IT Domain Cluster = Domain **Scope** Statements + Domain **Competencies** + Subdomains

ITE-GPP Domain: Global Professional Practice																										
Scope		Competencies																								
<ol style="list-style-type: none">Importance of identifying and understanding essential skills required for a successful career within the industry, including professional oral and written communication skills.Identification of ways teamwork integrates throughout IT and ways IT supports an organizationSocial and professional contexts of information technology and computing, and adherence to ethical codes of conduct		<ol style="list-style-type: none">Analyze the importance of communication skills in a team environment and determine how these skills contribute to the optimization of organization goals. (<i>Communication and teamwork</i>)Evaluate the specific skills necessary for maintaining continued employment in an IT career that involves system development in an environmental context. (<i>Employability</i>)Develop IT policies within an organization that include privacy, legal, and ethical considerations as they relate to a corporate setting. (<i>Legal and ethical</i>)Evaluate related issues facing an IT project and develop a project plan using a cost/benefit analysis including risk considerations in creating an effective project plan from its start to its completion. (<i>Project management</i>)																								
Subdomains																										
<table><tbody><tr><td>ITE-GPP-01</td><td>Perspectives and impact [L1]</td><td>ITE-GPP-07</td><td>Intellectual property [L1]</td></tr><tr><td>ITE-GPP-02</td><td>Professional issues and responsibilities [L1]</td><td>ITE-GPP-08</td><td>Project management principles [L1]</td></tr><tr><td>ITE-GPP-03</td><td>IT governance and resource management [L1]</td><td>ITE-GPP-09</td><td>Communications [L1]</td></tr><tr><td>ITE-GPP-04</td><td>Risk identification and evaluation [L1]</td><td>ITE-GPP-10</td><td>Teamwork and conflict management [L1]</td></tr><tr><td>ITE-GPP-05</td><td>Environmental issues [L1]</td><td>ITE-GPP-11</td><td>Employability skills and careers in IT [L1]</td></tr><tr><td>ITE-GPP-06</td><td>Ethical, legal, and privacy issues [L1]</td><td>ITE-GPP-12</td><td>Information systems principles [L1]</td></tr></tbody></table>			ITE-GPP-01	Perspectives and impact [L1]	ITE-GPP-07	Intellectual property [L1]	ITE-GPP-02	Professional issues and responsibilities [L1]	ITE-GPP-08	Project management principles [L1]	ITE-GPP-03	IT governance and resource management [L1]	ITE-GPP-09	Communications [L1]	ITE-GPP-04	Risk identification and evaluation [L1]	ITE-GPP-10	Teamwork and conflict management [L1]	ITE-GPP-05	Environmental issues [L1]	ITE-GPP-11	Employability skills and careers in IT [L1]	ITE-GPP-06	Ethical, legal, and privacy issues [L1]	ITE-GPP-12	Information systems principles [L1]
ITE-GPP-01	Perspectives and impact [L1]	ITE-GPP-07	Intellectual property [L1]																							
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ITE-GPP-06	Ethical, legal, and privacy issues [L1]	ITE-GPP-12	Information systems principles [L1]																							

L1, L2, L3 levels

- relative metric for the degree of engagement associated with subdomain learning proficiency

Profil Lulusan Teknologi Informasi

- Pemecah masalah kolaboratif, praktisi terampil, atau peneliti penelitian terapan yang menikmati mendapatkan teknologi untuk bekerja secara efektif dan memenuhi kebutuhan pengguna dalam berbagai pengaturan.
- Mampu bekerja sama untuk **mengintegrasikan** teknologi baru di tempat kerja dan masyarakat dan memastikan pengalaman yang unggul dan produktif bagi pengguna dan semua fungsi organisasi.
- Dalam lingkungan perusahaan, mampu menerapkan pemahaman mereka tentang **integrasi, pengembangan**, dan mengoperasi sistem; menyebarkan dan mengelola layanan dan platform Teknologi Informasi yang memenuhi tujuan dan sasaran bisnis organisasi.
- Di masyarakat, mampu menggunakan keahlian mereka dalam menerapkan berbagai solusi Teknologi Informasi untuk mendukung proyek dan kegiatan anggota masyarakat.
- Profesional yang siap untuk melakukan tugas dengan cara yang etis. Mereka akrab dengan berbagai undang-undang dan peraturan yang mengatur pengembangan dan operasi platform Teknologi Informasi yang mereka pertahankan.

Profil Lulusan Teknologi Informasi

- Mampu menjelaskan dan membenarkan keputusan profesional dalam bahasa yang dipahami oleh manajemen dan klien. Mereka menyadari implikasi anggaran dari alternatif teknologi dan dapat mempertahankan anggaran dengan benar.
- Memiliki praktik ekstensif dengan mengamankan jaringan Teknologi Informasi, aplikasi, pusat data, dan layanan online dengan benar.
- Mampu mencari solusi teknologi yang aman tanpa terlalu mempengaruhi kemampuan pengguna untuk mencapai tujuan mereka.

Capaian Pendidikan: Profil Lulusan **Teknologi Informasi**

Capaian pendidikan yang menentukan profil lulusan Teknologi Informasi adalah sbb:

1. Menganalisis masalah dunia nyata yang kompleks untuk mengidentifikasi dan menentukan persyaratan komputasi dan menerapkan pendekatan komputasi untuk proses pemecahan masalah.
2. Merancang, menerapkan, dan mengevaluasi solusi berbasis komputasi untuk memenuhi seperangkat persyaratan komputasi tertentu dalam konteks disiplin Teknologi Informasi.
3. Mengkomunikasikan secara efektif dengan khalayak yang beragam informasi teknis yang konsisten dengan khalayak dan tujuan yang dituju.
4. Membuat penilaian terinformasi dan memasukkan perspektif unik orang lain dalam praktek komputasi berdasarkan prinsip-prinsip hukum dan etika
5. Berfungsi secara efektif pada tim dan menggunakan advokasi diri dan advokasi sebaya untuk mengatasi bias dalam interaksi, menetapkan tujuan, merencanakan tugas, memenuhi tenggat waktu, mengelola risiko, dan menghasilkan produk/servis.
6. Mengidentifikasi dan menganalisis kebutuhan pengguna dan mempertimbangkannya selama pemilihan, integrasi, dan administrasi sistem berbasis komputer.

Information Technology vs Computer Science (1)

Information Technology

- deals with the development, implementation, support, and management of computers and information systems.
- involves working both with hardware (e.g. CPUs, RAM, hard-disks) and software (e.g. operating systems, web browsers, mobile applications).

Computer Science

- deals with the development and testing of software and software systems.
- involves working with mathematical models, data analysis and security, algorithms, and computational theory.

Profession: Information Technology vs Computer Science (2)

IT Professionals

- make sure that computers, networks, and systems work well, whether they are used by home users, big companies, hospitals, governments, and so on.

Computer Scientists

- the ones who establish the computational principles that are the basis of all software we are using.
- Their work is behind data transfers and storage, security standards and encryption, and so on.

Specialist: Information Technology vs Computer Science (3)

IT Specialisations

- Network Administration
- System Administration
- IT Security
- Enterprise Systems
- IT Management
- International Biometrics
- IT Strategy and Innovation

Computer Science Specialisations

- Artificial Intelligence
- Machine Learning
- Human-Computer Interaction (HIC)
- Data Science
- Cyber Security
- Cloud Computing
- Video Game Development

Main Courses: Information Technology vs Computer Science (4)

Main Courses in IT

- Information Systems
- Network Engineering
- Operating Systems
- Database Fundamentals
- Information Security Fundamentals
- System Analysis
- Business Technology
- Hardware and Software Troubleshooting
- Network Administration
- IT Ethics

Main Courses in Computer Science

- Theory of computation
- Software security
- Computer graphics
- Algorithms and data structures
- Calculus
- Linear algebra
- Software engineering
- Web development
- Cryptography
- Programming

Skills: Information Technology vs Computer Science (5)

- The skills required to succeed as an IT specialist or Computer Scientist often overlap. While every job may have additional requirements, these are the most important skills you need to develop:
 - Troubleshooting
 - Analytical thinking
 - Communication (oral and written)
 - Project management
 - Attention to details
 - Creativity

Today-Skills: Information Technology vs Computer Science (6)

IT Skills

- Programming languages, especially scripting languages like Python and Powershell
- Troubleshooting methods
- Network configuration
- Security infrastructure like setting up firewalls and routers
- Ethical hacking or penetration testing
- Data administration skills like SQL

Computer Science Skills

- Programming languages like Python, C++, HTML, CSS, Javascript
- Statistics, algebra, and/or calculus
- Familiarity with code sharing platforms like GitHub
- Understanding of the software development lifecycle
- Artificial intelligence methods like machine learning and deep learning, and tools like Apache Spark and Hadoop
- Data analysis and database tools like SQL, MongoDB, PostgreSQL, Excel

US-Today Jobs and Salaries: Information Technology vs Computer Science (6)

Computer science jobs	Salary (average base pay in US, Glassdoor)	IT jobs	Salary (average base pay in US, Glassdoor)
Web developer	\$68,858	Computer technician	\$37,990
Robotics engineer	\$90,624	Helpdesk technician	\$40,837
Full stack developer	\$98,256	Cybersecurity specialist	\$78,444
Software engineer	\$104,749	System administrator	\$79,708
Artificial intelligence engineer	\$106,375	Database administrator	\$80,772
Back end engineer	\$107,941	Network administrator	\$84,570
Data scientist	\$114,673	Cloud engineer	\$109,541

CS/IT/IS Jobs Salary and Demand in US

Source: BLS, 2019; 2020; 2021; O*NET OnLine, 2021; Profita, 2020

CS/IT/IS Jobs	2020 Median Pay	Demand (2019-2029)
Software Developer	\$110,140 per year	22%
Database Administrator	\$98,860 per year	10%
Computer Hardware Engineer	\$119,560 per year	2%
Computer Systems Analyst	\$93,730 per year	7%
Computer Network Architect	\$116,780 per year	5%
Web Developer & Digital Designer	\$77,200 per year	8%
Information Security Analyst	\$103,590 per year	31%
Computer and Information Research Scientists	\$126,830 per year	15%
Computer and Information Systems Managers	\$151,150 per year	10%
IT/IS Project Manager	\$92,870 per year	7%

BEST TECHNOLOGY JOBS 2021 IN US

Jobs	Educated Needed	Median Salary	Unemployment Rate	Projected Jobs (2019-2029)
1. Software Developer	Bachelor's	\$107,510	1.4%	316,000
2. Data Scientist	Bachelor's	\$94,280	3.5%	10,300
3. IT Manager	Bachelor's	\$146,360	1.3%	48,100
4. Information Security Analyst	Bachelor's	\$99,730	2.7%	40,900
5. Computer Systems Analyst	Bachelor's	\$90,920	1.5%	46,600
6. Computer Network Architect	Bachelor's	\$112,690	0.7%	8,000
7. Database Administrator	Bachelor's	\$93,750	1.7%	12,800
8. Web Developer	Associate's	\$73,760	2.5%	14,000
9. Computer Systems Administrator	Bachelor's	\$83,510	3.1%	16,000
10.Computer Support Specialist	Some College, No degree	\$52,270	3.3%	54,800

Bagian 2

BoK CC2020 + IT2017

Model Arsitektur Kurikulum **Teknologi Informasi** Berdasarkan CC 2020 dan IT2017

Pengetahuan Wajib Setiap Prodi INFOKOM

1	Social Issues and Professional Practice	6	Systems Analysis & Design	11	Security Technology and Implementation	16	Data Structures, Algorithms & Complexity
2	Security Policy and Management	7	Data and Information Management	12	Software Quality, Verification and Validation	17	Programming Languages
3	Project Management	8	Virtual Systems and Services	13	Software Modeling and Analysis	18	Programming Fundamentals
4	User Experience Design	9	Parallel and Distributed Computing	14	Software Design	19	Computing Systems Fundamentals
5	Security Issues and Principles	10	Computer Networks	15	Operating Systems	20	Architecture and Organization

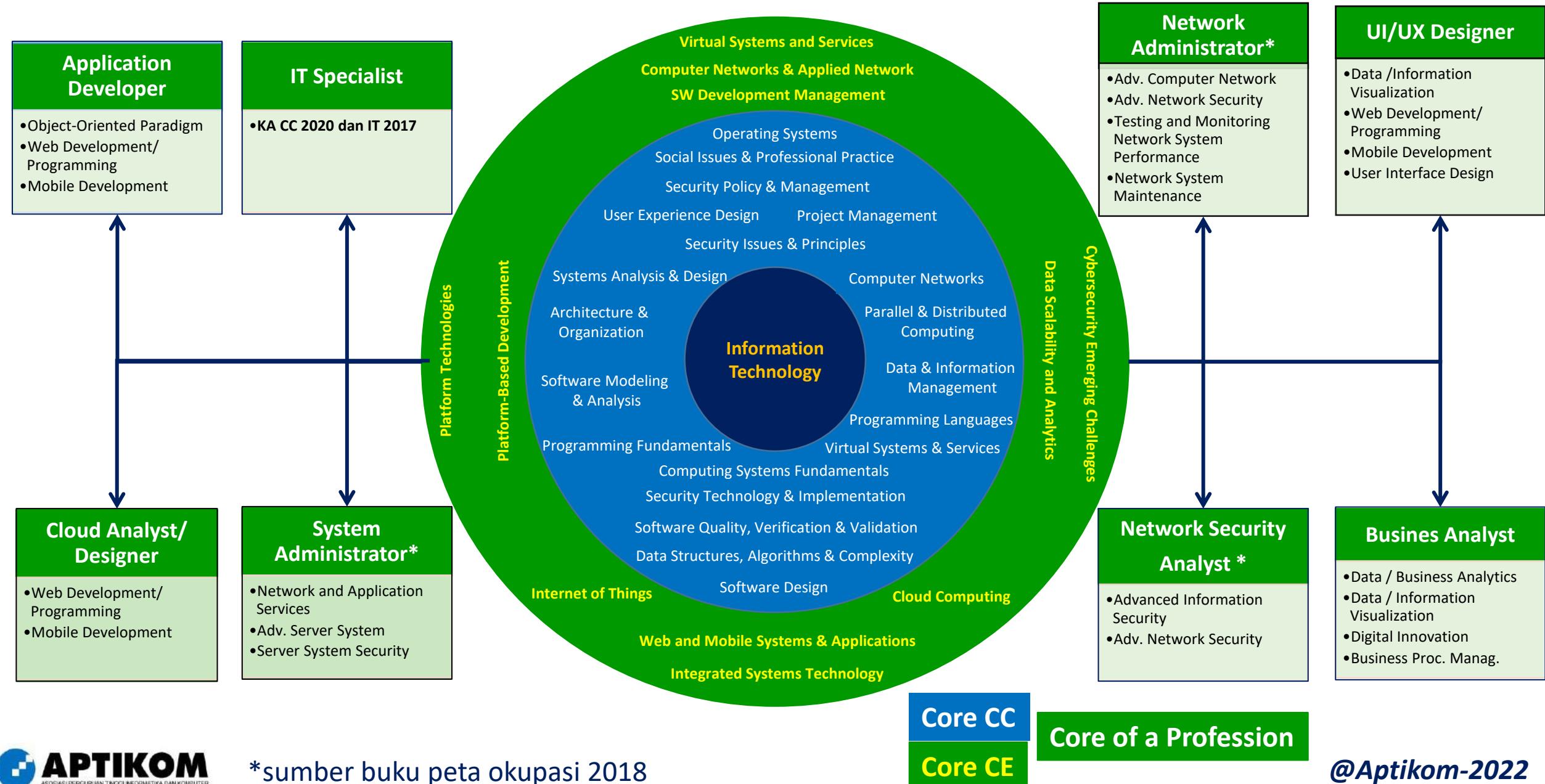
Pengetahuan Inti per Prodi Infokom

Teknologi Informasi CC 2020		Teknologi Informasi IT2017		Teknologi Informasi CC2020+IT2017	
		10 Essential Domains (40%)	9 Supplemental Domains (20%)		
1	Virtual Systems and Services	1 ITE-CSP Cybersecurity Principles (6%)	1 ITE-ANE Applied Networks (4%)	1 Virtual Systems and Services	
2	Internet of Things	2 ITE-GPP Global Professional Practice (3%)	2 ITE-CCO Cloud Computing (4%)	2 Internet of Things	
3	Computer Networks	3 ITE-IMA Information Management (6%)	3 ITE-CEC Cybersecurity Emerging Challenges (4%)	3 Computer Networks & Applied Network	
4	Integrated Systems Technology	4 ITE-IST Integrated Systems Technology (3%)	4 ITE-DSA Data Scalability and Analytics (4%)	4 Integrated Systems Technology	
5	Platform Technologies	5 ITE-NET Networking (5%)	5 ITE-IOT Internet of Things (4%)	5 Platform Technologies	
6	Platform-Based Development	6 ITE-PFT Platform Technologies (1%)	6 ITE-MAP Mobile Applications (3%)	6 Platform-Based Development	
		7 ITE-SPA System Paradigms (6%)	7 ITE-SDM SW Development Management (2%)	7 Cloud Computing	
		8 ITE-SWF Software Fundamentals (4%)	8 ITE-SRE Social Responsibility (2%)	8 Cybersecurity Emerging Challenges	
	Warna merah dan hijau: ada di CC 2020	9 TTE-UXD User Experience Design (3%)	9 ITE-VSS Virtual Systems and Services (4%)	9 Data Scalability and Analytics	
		10 ITE-WMS Web and Mobile Systems (3%)	Warna merah dan hijau: ada di CC 2020	10 Web and Mobile Systems & Applications	
				11 SW Development Management	

Contoh Pengetahuan (Kompetensi di IT2017 dan Peta Okupasi) untuk Profesi Sasaran

IT Specialist		Network Security Analyst		System Administrator		Network Administrator	
1	KA CC 2020 dan IT 20117	1	Adv. Information Security	1	Network and Application Services	1	Adv. Computer Network
2		2	Adv. Network Security	2	Adv. Server System	2	Adv. Network Security
3				3	Server System Security	3	Testing and Monitoring Network System Performance
4						4	Network System Maintenance
UI/UX Designer		Application Developer		Business Analyst		Cloud Analyst/Designer	
1	Data / Information Visualization	1	Object-Oriented Paradigm	1	Data / Business Analytics	1	Web Development/Programming
2	Web Development/Programming	2	Web Development/Programming	2	Data / Information Visualization	2	Mobile Development
3	Mobile Development	3	Mobile Development	3	Digital Innovation		
4	User Interface Design			4	Business Process Management		

BoK of CE Curricula based on CC-2020 and IT-2017, and Sample Profession Knowledge





Informasi Singkat: Body of Knowledge and The Building Blocks for a Competence-Based EU-AI Curriculum for Master-Program

Source: Artificial intelligence masters' programs -An analysis of curricula building blocks, Dodero, J.M., 2021
Joint Research Centre (JRC), the European Commission's science and knowledge service

Achmad Benny Mutiara

Dekan Fakultas Ilmu Komputer dan Teknologi Informasi, Universitas Gunadarma
SEKJEN-APTIKOM

2021



Pendahuluan

Tujuan dan Harapan

- Laporan ini mengidentifikasi blok bangunan **program master** tentang **Kecerdasan Artifisial (AI)**, berdasarkan program yang ada dan tersedia di Uni Eropa (UE).
- **Analisis** pelatihan akademik “**post-graduate**” yang terkait dengan **AI** telah dilakukan untuk menentukan karakteristik program tingkat master **AI** UE yang ada dan untuk membantu otoritas pendidikan tinggi memiliki pemahaman yang sama

Lingkup Kecerdasan Artifisial (AI)

- AI mencakup metodologi untuk memodelkan dan mensimulasikan beberapa kemampuan manusia yang diterima secara luas sebagai representasi kecerdasan.
- Persepsi, representasi, pembelajaran, perencanaan, dan penalaran (baik dengan pengetahuan lengkap atau tidak pasti dan bukti parsial) adalah tema kunci tradisional dalam AI.
- Menghasilkan pengetahuan untuk komunikasi manusia-AI yang berguna juga merupakan tema utama, meskipun kurang berkembang dibandingkan sebelumnya.
- Kemampuan manusia ini membentuk **domain inti AI** seperti yang didefinisikan dalam laporan **AI Watch** yang mengusulkan **definisi operasional AI** (Samoili et al., 2020a).

Lingkup Kecerdasan Artifisial (AI)

- Definisi operasional AI yang diusulkan oleh AI Watch didasarkan pada definisi AI yang dikembangkan oleh Kelompok Pakar Tingkat Tinggi tentang AI. Definisi sbb.:

“Artificial intelligence (AI) systems are software (and possibly also hardware) systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best action(s) to take to achieve the given goal. AI systems can either use symbolic rules or learn a numeric model, and they can also adapt their behaviour by analysing how the environment is affected by their previous actions”

Lingkup Kecerdasan Artifisial (AI)

- Konsep dan metode yang dikembangkan oleh disiplin AI telah dimasukkan dan dianalisis dalam rekomendasi kurikulum yang ada untuk keragaman domain Informatika yang terkait erat, seperti Ilmu Komputer, Sains Data, Teknologi Informasi dan Keamanan Siber.
- Rekomendasi kurikuler di bidang ini yang membatasi ruang lingkup AI dan dengan demikian relevan untuk kurikulum AI yang dijelaskan di bawah ini. Mereka didasarkan pada proyek IEEE/ACM Computing Curricula 2020 (CC2020), yang mengusulkan pergeseran filosofis dalam format dan penekanan kurikulum melalui **adopsi model berbasis kompetensi** untuk spesifikasi kurikulum.
- Laporan ini akan melampaui kurikulum Informatika, karena juga akan mempertimbangkan **konten etis** dan **filosofis** yang melengkapi Informatika dan bidang terkait teknologi informasi lainnya.

Metodologi

■ Metodologi pengembangan tugas yang diperlukan untuk penelitian ini terdiri dari langkah-langkah berikut:

- Analisis isi program
- Identifikasi kurikulum **AI** yang ada
- Penilaian kesamaan (Assessment of similarities)
- Definisi blok bangunan untuk draf kurikulum **AI**
 - Proposal blok bangunan untuk kurikulum **AI** didasarkan pada hasil dari langkah 1 dan 2, dan dikembangkan mengikuti kerangka berbasis kompetensi yang memadai.
 - Langkah ini telah menghasilkan draf pertama dari blok bangunan untuk kurikulum **AI**. Tugas ini didukung oleh interaksi dengan profesor akademisi dengan keahlian di berbagai bidang **AI** dan pengembangan kurikulum. Karya lengkap terkait yang menjadi referensi tambahan adalah sebagai berikut:
 - The IEEE/ACM Cybersecurity (CSEC) 2017 curricula
 - The IEEE/ACM Information Technology (IT) 2017 curricula
 - The IEEE/ACM Computing Curricula (CC) 2020
 - The Competence Based Framework for Curriculum Development, focused on ICT training, produced under the TEMPUS project
 - The IEEE/ACM Data Science (DS) 2021 curricula

Metodologi

- Proposal kurikulum AI mencakup konten khusus AI yang akan dibahas, serta karakteristik lain seperti yang dianalisis dalam subtugas sebelumnya (subdomain AI, durasi, jumlah kredit, dll.).
- Laporan ini tidak mengusulkan kurikulum tertutup, tetapi portofolio konten dan karakteristik, blok bangunan yang dapat dipilih oleh lembaga pendidikan untuk menyusun master khusus AI mereka. Dengan cara ini, kurikulum AI dapat dikembangkan mencakup topik inti dan topik horizontal, kuliah teoretis dan kuliah terapan, dll



Konteks

- **AI** lahir dalam konteks disiplin ilmu yang mapan seperti Matematika dan Informatika.
- Dalam konteks akademik, **AI** saat ini dianggap sebagai area pengetahuan dalam lingkup luas Informatika yang memiliki struktur informasi yang sama yang merupakan inti dari Matematika dan Informatika.
- Inti dari Informatika akademik di sebagian besar universitas adalah departemen/jurusan/prodi Ilmu Komputer dan Teknik Komputer.
- Oleh karena itu, Informatika, Ilmu Komputer, dan Teknik Komputer adalah disiplin dasar yang mendasari **AI**.
 - Pendekatan kuantitatif dan matematis **AI** sebagai disiplin Teknik Informatika dan Komputer berasal dari departemen akademik Statistik dan Riset Operasional. Pengetahuan, konsep, dan metode dari semua disiplin ilmu ini harus diperhitungkan sebagai konteks utama untuk mengusulkan kurikulum **AI**.

Taksonomi *AI Watch*

Sebagai taksonomi dasar untuk **AI**, kita menganggap sebagai titik awal yang diuraikan sebagai bagian dari **definisi operasional AI**, yang dikembangkan dalam konteks *AI Watch* (Samoili et al., 2020), seperti yang digambarkan pada Tabel 1.

Tabel 1. Taksonomi yang diusulkan dalam laporan *AI Watch*
(Sumber: *AI Watch*)

		Taksonomi AI	
		Domain AI	Subdomain AI
Inti AI	Transversal	Reasoning	Knowledge representation
			Automated reasoning
			Common sense reasoning
		Planning	Planning and Scheduling
			Searching
			Optimisation
		Learning	Machine learning
		Communication	Natural language processing
		Perception	Computer vision
			Audio processing
		Integration and Interaction	Multi-agent systems
			Robotics and Automation
			Connected and Automated vehicles
		Services	Layanan KA
		Ethics and Philosophy	Etika KA
			Filosofi KA

Taksonomi *AI Watch*

Domain inti AI ditentukan oleh kemampuan manusia dan tujuan yang ingin dipenuhi oleh **AI**. Kemampuan manusia tersebut terutama *representing, planning, reasoning, learning, communicating, perceiving* dan *acting* (Russell & Norvig, 2016). Selain itu, **domain transversal** umum untuk semua domain inti.

Karena kebetulan terminologis dari **domain AI** dan konsep bahasa umum di luar ranah Informatika dan **AI**, perlu untuk menentukan lebih lanjut arti dari nama pendek yang digunakan untuk domain tersebut:

- **Representation** dan **reasoning** mengacu pada metode komputasi untuk mengotomatisasi penalaran (reasoning), perencanaan (planning), penjadualan (scheduling) dan mengoptimalkan (optimising) solusi untuk masalah yang direpresentasikan secara formal dalam representasi pengetahuan yang dapat dipahami mesin.
- **Learning** (pembelajaran) mengacu pada metode komputasi dan algoritma yang meningkat melalui pengalaman. Ini melibatkan keduanya pembelajaran simbolik dan pembelajaran statistik dengan mesin.

Taksonomi *AI Watch*

- **Integration dan Interaction** mengacu pada karakteristik seperti distribusi, koordinasi, kerjasama, dan otonomi sistem cerdas ketika bertindak dengan lingkungan, serta kombinasi dari kemampuan lain (yaitu Persepsi, Penalaran, Pembelajaran dan Interaksi).
- **Communication** terutama mengacu pada metode dan teknik linguistik komputasi, termasuk pemrosesan bahasa alami. Tetapi juga melibatkan sarana komunikasi non-verbal, yang juga merupakan topik interaksi.
- **Perception** berarti kemampuan sistem komputer untuk menafsirkan data dengan cara yang mirip dengan cara manusia menggunakan indera mereka untuk berhubungan dengan dunia di sekitar mereka, terutama melalui visi komputer (computer vision) dan pemrosesan audio.
- **Services dan Applications** mengacu pada infrastruktur, perangkat lunak, dan platform apa pun yang disediakan sebagai layanan atau aplikasi digital, yang tersedia dan dijalankan sesuai permintaan.
- **Ethics & Philosophy** mencakup masalah filosofis dan etika yang terkait dengan **AI** dan terkait dengan kepatuhan terhadap prinsip dan nilai etika, termasuk peraturan yang berlaku.

Taksonomi *AI Watch*

- **Subdomain AI** yang terungkap dari taksonomi *AI Watch* adalah sebagai berikut:

- Knowledge Representation (KR)
- Automated Reasoning (AR)
- Planning and Scheduling (PS)
- Optimisation and Searching (OS)
- Machine Learning (ML)
- Natural Language Processing (NLP)
- Computer Vision (CV)

- Audio Processing (AP)
- Human-Computer Interaction (HCI)
- Multi-Agent Systems (MAS)
- Robotics & Intelligent Automation (RIA)
- Connected and Automated Vehicles (CAV)
- AI Ethics (AIE)
- Philosophy of AI (PAI)

- Subdomain ini dilengkapi dengan subdomain **AI Services (AIS)** , yang meng-kompilasi sejumlah layanan dan aplikasi **AI** di berbagai bidang.

Kurikulum tentang **AI** dan **bidang terkait**

- Konteks di mana proposal kurikulum **AI** yang baru harus dipahami adalah konteks Informatika atau Komputasi, yang merupakan subjek IEEE/ACM CC 2020.
- Meskipun laporan **CC2020** tidak menyertakan kurikulum **AI** formal yang didukung secara profesional, **AI** diakui di **CC2020** sebagai bidang studi dengan minat baru.
- Lebih lanjut, diakui bahwa rekomendasi kurikuler di bidang **AI** berpotensi muncul dalam beberapa tahun ke depan.



Kerangka (Framework) Kurikulum KA

- Laporan ini dan blok bangunan yang diusulkan untuk kurikulum **KA** akan mengatur disiplin **AI** di sekitar **Area Pengetahuan (Knowledge Area (KA))**, yang untuk tujuan analisis, awalnya akan ditentukan berdasarkan **domain AI** dari laporan **AI Watch**.
- Setiap **KA** terdiri dari pengetahuan kritis dalam disiplin AI dan di seluruh disiplin ilmu berbasis Informatika terkait lainnya.
- Setiap area pengetahuan dibagi dalam **Unit Pengetahuan (Knowlegde Unit (KU))**, yang terdiri dari topik-topik
- Selain kerangka kurikuler berbasis pengetahuan ini, untuk setiap topik, sejumlah **learning outcomes** ditentukan untuk mengukur keterampilan dan kompetensi dari kerangka berbasis kompetensi yang akan dijelaskan di bawah ini.
- **Learning outcomes** merupakan gambaran tentang apa yang seharusnya diketahui atau dapat dilakukan oleh siswa.
- Isi topik dan **learning outcomes** untuk kurikulum tertentu akan dipengaruhi oleh lensa disiplin dan jenis institusi yang akan menentukan **program magister**. Kerangka berbasis kompetensi dan proposal kurikulum terkait dijelaskan dalam bagian terpisah di bawah ini

Knowledge Areas (KA)

■ **Knowledge Areas** kerangka kurikuler ini telah didasarkan pada **domain AI** pada Tabel 1 dan dipecah dalam **sembilan KA** berikut:

- Reasoning
- Planning and Optimization
- Learning
- Communication
- Perception
- Integration
- Interaction
- Services
- Ethics and Philosophy

Knowledge Units (KU)

- **Knowledge units (KU)** kerangka kurikuler untuk tujuan analisis pada awalnya didasarkan pada **subdomain AI** dan kata kunci terkait yang ditentukan oleh laporan **AI Watch**. Berikut ini adalah daftar **subdomain AI** yang dicakup oleh **AI Watch**:

- Knowledge Representation
- Automated Reasoning
- Planning and Scheduling
- Optimisation and Searching
- Machine Learning
- Natural Language Processing
- Computer Vision

- Audio Processing
- Human-Computer Interaction
- Multi-Agent Systems
- Robotics & Intelligent Automation
- Connected and Automated Vehicles
- AI Ethics
- Philosophy of AI

- Laporan *AI Watch* juga mengusulkan daftar kata kunci untuk menganalisis konten dan topik setiap **subdomain AI**.
- Kata kunci dari beberapa subdomain, misalnya Representasi Pengetahuan dan Penalaran Otomatis) **tidak** diklasifikasikan secara terpisah dalam salah satu dari dua subdomain. Oleh karena itu kedua subdomain harus dikelompokkan dalam satu unit yang sesuai dengan subdomain Representasi Pengetahuan dan Penalaran.
- Hal yang sama terjadi pada subdomain Perencanaan & penjadwalan, Pencarian dan Pengoptimalan, yang dikelompokkan dalam satu subdomain Perencanaan, Pencarian, dan Pengoptimalan.

■ Oleh karena itu, **subdomain AI** yang layak digunakan untuk menganalisis program magister adalah sebagai berikut:

- Knowledge Representation & Reasoning (KRR)
- Planning & Scheduling, Searching and Optimization(PSO)
- Machine Learning (ML)
- Natural Language Processing (NLP)
- Computer Vision (CV)
- Audio Processing (AP)
- Human-Computer Interaction (HCI)
- Multi-Agent Systems (MAS)
- Robotics & Intelligent Automation (RIA)
- Connected and Automated Vehicles (CAV)
- AI Ethics (AIE)
- Philosophy of AI (PAI)

Horizontal areas

- Daftar subdomain ***AI Watch*** yang dibuka akan ditambah dengan yang berikut yang mencakup topik horizontal dan transversal:
 - Fundamental Informatics/Computing (FIC)
 - Fundamental Maths & Statistics (FMS)

Disciplinary lenses

- Lensa disiplin mewakili disiplin ilmu yang mendasari dari mana kurikulum AI dapat dikembangkan. Lensa disiplin mendorong pendekatan, kedalaman konten, dan **learning outcomes** yang diharapkan untuk topik dan keterampilan AI.
- Lensa disiplin mencakup disiplin ilmu yang diidentifikasi oleh kurikulum IEEE/ACM
- Selain itu, disiplin ilmu lain, seperti Ilmu Kognitif, Linguistik Komputasi, Matematika Terapan, dan beragam gelar Teknik, dapat juga merupakan lensa disiplin yang valid untuk program AI yang dirancang berdasarkan kurikulum yang diusulkan.
- Konten AI juga dapat diajarkan dalam disiplin ilmu lain yang juga dapat menjadi lensa disiplin, seperti Kesehatan dan Kedokteran (misalnya, Informatika Medis); Biosains (misalnya Biotek dan Bioinformatika); Bisnis dan Administrasi (misalnya Fintech); dan Seni dan Humaniora (misalnya kreativitas komputasi dalam Seni Rupa).

Disciplinary lenses

- Klasifikasi program magister, menurut jurusan/sekolah atau kelompok penelitian/bidang yang membidangi master, memasukan nilai-nilai berikut sebagai lensa disiplin:
 - Business and management
 - Electrical & Electronic Engineering
 - Engineering (general)
 - Health & Life Sciences
 - Humanities & Social Sciences
 - Linguistics
 - Mechanical Engineering
 - Informatics/Computing
 - Psychology, Cognitive & Behavioural Sciences
 - Laws

Topik-Topik AI

- Topik AI telah diklasifikasikan menurut kata kunci AI Watch, yang digambarkan dalam Lampiran A: kata kunci dan topik AI.
- Kata kunci ini telah diperluas dengan istilah yang sering muncul dalam contoh program master.



APTIKOM



Body of Knowledge

Body of Knowledge: KA, KU, Topik AI, Keywords

Knowledge Area / AI domain	Knowledge Unit / AI subdomain	AI Topic	Keywords
Reasoning & Planning	Knowledge Representation & Automated Reasoning	Case-based reasoning	case-based reasoning
		Causal models & inference	causal inference causal models
		Common sense reasoning	common-sense reasoning
		Expert systems	expert system
		Probabilistic models	graphical models bayesian modelling bayesian network probabilistic learning probabilistic model markov network
		Information theory	information theory
		Knowledge representation & reasoning	knowledge representation automated reasoning
		Latent & factor analysis	latent variable model factorization principal component analysis
		Semantics & ontologies	semantic web ontology knowledge graph linked data
		Soft computing & uncertainty	fuzzy logic uncertainty in AI
Planning & Scheduling & Searching & Optimisation	Planning & Scheduling & Searching & Optimisation	Bayesian optimisation	bayesian optimisation
		Constraint satisfaction	constraint satisfaction
		Evolutionary & genetic algorithms	evolutionary algorithm genetic algorithm
		Energy formulation	energy formulation gradient descent
		Heuristics & metaheuristics	heuristic optimisation metaheuristic optimisation
		Planning graph & activities	hierarchical task network planning graph planning & activity management
		Stochastic optimisation	stochastic optimisation simulation

Body of Knowledge: KA, KU, Topik AI, Keywords

Knowledge Area / AI domain	Knowledge Unit / AI subdomain	AI Topic	Keywords
Learning	Machine learning	Active & adaptive machine learning	active learning adaptive learning
		Adversarial & generative machine learning	adversarial machine learning adversarial network generative adversarial network generative model
		Anomaly detection	anomaly detection
		Artificial neural networks	artificial neural network neural network
		Automated machine learning	automated machine learning automatic classification automatic recognition
		Ensemble methods	bagging boosting ensemble method
		Classification & supervised learning	classification supervised learning

Body of Knowledge: KA, KU, Topik AI, Keywords

Knowledge Area / AI domain	Knowledge Unit / AI subdomain	AI Topic	Keywords
			support vector machine
		Clustering & unsupervised learning	clustering
		Collaborative filtering	collaborative filtering
		Data mining & information retrieval	data mining information retrieval
		Deep learning	convolutional neural network deep learning deep neural network recursive neural network q-learning
		Feature & information extraction	feature extraction information extraction
		Multi-task learning	multi-task learning
		Recommender system	recommender system
		Recurrent neural networks	Recurrent neural network LSTM
		Reinforcement learning	reinforcement learning
		Semi-supervised learning	semi-supervised learning
		Statistical learning	statistical learning statistical relational learning
		Transfer learning	transfer learning

Body of Knowledge: KA, KU, Topik AI, Keywords

Knowledge Area / AI domain	Knowledge Unit / AI subdomain	AI Topic	Keywords
Communication	Natural Language Processing	Computational linguistics	computational linguistics linguistic linked data data-driven language engineering
		Dialog systems	chatbot conversation model dialogue system
		Coreference resolution	coreference resolution
		Information extraction	information extraction
		Machine translation	machine translation
		Natural language generation	natural language generation
		Natural language understanding	natural language processing natural language understanding
		Question answering	question answering
		Sentiment analysis	sentiment analysis
		Text classification	text classification
		Text mining	text mining unstructured data

Body of Knowledge: KA, KU, Topik AI, Keywords

Knowledge Area / AI domain	Knowledge Unit / AI subdomain	AI Topic	Keywords
Perception	Computer Vision	Action, gesture & motion recognition	action recognition gesture recognition motion recognition
		Image processing	image processing unstructured data
		Image retrieval	content-based filtering image retrieval visual search
		Pattern & object recognition	face recognition pattern recognition object recognition recognition technology
		Sensors	sensor network
	Audio Processing	Music & sound processing	computational auditory scene analysis
			music information retrieval
			sound description
			sound event recognition
			sound source separation
			sound synthesis
		Speech processing	speaker identification speech processing

Body of Knowledge: KA, KU, Topik AI, Keywords

Knowledge Area / AI domain	Knowledge Unit / AI subdomain	AI Topic	Keywords
		Speech recognition	speech recognition
		Speech synthesis	speech synthesis
Integration and Interaction	Multi-agent Systems	Intelligent multi-agent systems	agent-based modelling intelligent agent
		Computational economics	computational economics game theory
		Negotiation & agreement	agreement technologies negotiation algorithm
		Collective intelligence	network intelligence swarm intelligence
	Robotics & Intelligent Automation	Cognitive systems	cognitive system
		Control theory	control theory
		Distributed computing	distributed computing IoT
		Robotics	industrial robot robot system robotics service robot social robot
Connected and Automated Vehicles		Autonomous vehicles	autonomous driving
			autonomous system
			autonomous vehicle
			self-driving car
			unmanned vehicle
Human-Machine Interaction		Intelligent user interfaces	intelligent user interface
		Virtual environments & reality	virtual environment
			virtual reality
			augmented reality
		Multi-modal interaction	extended reality multi-modal interaction
		Human-robot interaction	human-robot interaction human-ai interaction
		Affective computing	affective computing
		Interaction & User Experience	usability user experience

Body of Knowledge: KA, KU, Topik AI, Keywords

Knowledge Area / AI domain	Knowledge Unit / AI subdomain	AI Topic	Keywords
Services & Applications	AI Services	AI Software toolkits	ai application
			ai benchmark
			ai competition
			ai software toolkit
		Big data	big data
		Business Intelligence	analytics platform
			business intelligence
		Computational creativity	computational creativity
		Computational neuroscience	computational neuroscience
		Decision support	data analytics
			decision analytics
			decision support
		Intelligent control	intelligence software
			intelligent control
			intelligent control system
		Machine learning toolkit	machine learning framework
			machine learning library
			machine learning platform
		Personal assistant	personal assistant
AI Ethics and Philosophy	AI Ethics	Accountability	accountability
		Explainability	explainability
		Fairness	fairness
		Privacy	privacy
		Safety	safety
		Security	security
		Transparency	transparency

Body of Knowledge: KA, KU, Topik AI, Keywords

Knowledge Area / AI domain	Knowledge Unit / AI subdomain	AI Topic	Keywords
AI Ethics and Philosophy	AI Ethics	Accountability	accountability
		Explainability	explainability
		Fairness	fairness
		Privacy	privacy
		Safety	safety
		Security	security
		Transparency	transparency

Knowledge Area / AI domain	Knowledge Unit / AI subdomain	AI Topic	Keywords
	Philosophy of AI	Artificial general intelligence	artificial general intelligence
		Strong artificial intelligence	strong artificial intelligence
		Weak artificial intelligence	weak artificial intelligence
			narrow artificial intelligence



Knowledge Area and Competency

Final Knowledge Area and Competency

■ 12 KA berikut Kompetensi-nya

- 1) AI General
- 2) Knowledge Representation & Reasoning (KRR)
- 3) Planning, Search & Optimization (PSO)
- 4) Machine Learning (ML)
- 5) Natural Language Processing (NLP)
- 6) Computational Perception (CP)
- 7) Robotics, Agents & Integration (RAI)
- 8) Human-Machine Interaction (HMI)
- 9) Philosophy & Ethics of AI (PEA)
- 10) AI Services (AIS)
- 11) Fundamental Informatics/Computing (FIC)
- 12) Fundamental Mathematics & Statistics (FMS)

Body of Knowledge for Graduate AI Curricula in EU



KA: AI General dan Kompetensi

The knowledge area of AI General includes all the competences in the realm of AI that involve knowledge, skills and dispositions that cannot be classified as specific of a given domain. The scope is that of AI and no specific KUs are defined.

The broad scope of AI General is that of systems designed by humans that, given a complex goal, act in the physical or digital dimension by perceiving their environment through data acquisition, interpreting the collected structured or unstructured data, reasoning on the knowledge, or processing the information, derived from this data and deciding the best actions to take to achieve the given goal.

6.1.1 Competences

SKILLS	
3-apply	
	Choose appropriate tools and implement efficient solutions to problems in AI
4-analyse	
	Choose an appropriate AI method to address the needs of a given application setting
6-create	
	Design, conduct and publish original AI research
	Design new tools and new techniques of Artificial Intelligence in professional practice
	Design, conduct and critique original research to address questions and challenges in the design and use of systems involving humans and AI
DISPOSITIONS	
	Possess an attitude of approaching and investigating AI and AI-problems from a multi-disciplinary perspective
	Insight of what the major areas of concern are in AI, as well as the types of problems they address, in order to know where to look for approaches when needed, thus avoiding rediscovery of existing methods
	Reflect on and discuss current social and ethical aspects of AI

KA: Knowledge Representation & Reasoning (KRR) dan Kompetensi

6.2.1 Scope	6.2.2 Knowledge Units
Representation of information and knowledge in logic and probabilistic formalisms. Application of automated reasoning methods to the represented information and knowledge.	Case-based reasoning Causal models & inference Common sense reasoning Expert systems Probabilistic models Information theory Knowledge representation & reasoning Latent & factor analysis
	Semantics & ontologies Soft computing & uncertainty

6.2.3 Competences

SKILLS	
3-apply	Demonstrate how Bayesian networks can be used to make inferences; describe approaches for efficient reasoning (Belief Propagation) Apply a learning algorithm to construct a Bayesian network for a small- or medium-sized problem Apply a reinforcement learning algorithm to an appropriate problem Apply a probabilistic logic model to a small- or medium-sized problem
4-analyse	Choose an appropriate knowledge representation approach to address the needs of a given application setting Choose an appropriate automated reasoning approach to address the needs of a given application setting Demonstrate contexts in which Markov Decision Processes can be useful (e.g., optimization or control problems)
5-evaluate	Critically evaluate knowledge representation alternatives to solve a given task Implement and evaluate automated reasoning approaches to solve a given task

KA: Planning, Search & Optimization (PSO) dan Kompetensi

6.3.1 Scope	6.3.2 Knowledge Units
<p>Methods for planning and executing solutions by intelligent systems.</p> <p>[The scope of this area may have an overlap with FIC fundamental concepts, such as programming methodologies.]</p>	<p>Bayesian optimisation Constraint satisfaction Evolutionary & genetic algorithms Energy formulation Heuristics & metaheuristics Planning graph & activities Stochastic optimisation</p>

6.3.3 Competences

SKILLS	
3-apply	
	Apply a stochastic search approach (e.g., genetic algorithms, simulated annealing)
	Apply a knowledge representation formalism to a problem
	Apply a constraint-satisfaction algorithm to a small- or medium-sized problem
6-create	
	Formalize simple problems with a given knowledge representation approach
	Implement search algorithms
DISPOSITIONS	
	Appreciate that there may be multiple acceptable solutions in a state space, as well as multiple problem-solving approaches, depending on the need for optimality, time constraints, etc.
	Appreciate the relationship between algorithm, heuristics, and optimality of solution to a problem

KA: Machine Learning (ML) dan Kompetensi

6.4.1 Scope	6.4.2 Knowledge Units
Algorithms that improve through experience to identify patterns in data to build models in order to gain valuable information. It includes the processing, analysis and presentation of data.	Active & adaptive machine learning Adversarial & generative machine learning Anomaly detection Artificial neural networks Automated machine learning Ensemble methods Classification & supervised learning Clustering & unsupervised learning Collaborative filtering Data mining & information retrieval Deep learning Feature & information extraction Multi-task learning Recommender system Recurrent neural networks Reinforcement learning Semi-supervised learning Statistical learning Transfer learning

KA: Machine Learning (ML) dan Kompetensi

6.4.3 Competences

SKILLS	
3-apply	<p>Optimize the main trade-offs such as overfitting, and computational cost vs accuracy</p> <p>Apply appropriate machine learning technique for classification, pattern recognition, regression and decision problems</p> <p>Identify software to support classification and regression and apply the software</p>
4-analyse	<p>Discuss advantages with and limitations of machine learning for different applications</p> <p>Choose an appropriate machine learning method and data pre-processing strategy to address the needs of a given application setting</p> <p>Recognize the type of learning problem and select appropriate algorithms</p> <p>Compare clustering approaches, highlighting relative benefits and shortcomings</p>
5-evaluate	<p>Evaluate the suitability of different machine learning methods for solving a new problem encountered, and apply the methods to the problem</p>
6-create	<p>Derive, explain and apply practical machine learning methods and algorithms</p> <p>Design, implementation, deployment and analysis of deep learning architectures addressing complex problems in several applicative areas</p> <p>Select and program pattern recognition methods and learning based on the type of problem, after distinguishing if the situation so requires</p>
DISPOSITIONS	<p>Critically appraise the ethical implications and societal risks associated with the deployment of machine learning methods</p> <p>Reflect on the importance of data representation for the success of machine learning methods</p> <p>Depicting links between classification and regression, and more generally statistics, as well as machine learning</p> <p>Understanding the limits and potentials of advanced machine learning models</p>

KA: Natural Language Processing (NLP) dan Kompetensi

6.5.1 Scope	6.5.2 Knowledge Units
Collection and parsing of text data to generate and understand human languages	Computational linguistics Dialog systems Machine translation Natural language generation Natural language understanding Question answering Sentiment analysis Text classification Text mining

6.5.3 Competences

SKILLS	
3-apply	
	Understand the basic operation principles of NLP techniques in an intelligent system
	Combine dependency parsing with data-driven statistical methods
5-evaluate	
	Critically evaluate and select software tools appropriate for building NLP applications
6-create	
	Engineer an NLP application in a rigorous and principled manner
	Implement a dependency parser

- KA lainnya dapat dilihat di:

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Terima Kasih