

Overview of Informatics Curriculum for beginners at universities (Plan)

Competency	Areas	Knowledge area of Computer Science Curricula 2013 (CS2013)	Required class hours	Optional class hours
Technical understanding of computer science / Familiarity with common themes and principles / Appreciation of the interplay between theory and practice / System-level perspective / Problem solving skills / Commitment to life-long learning / Commitment to professional responsibility / Awareness of the broad applicability of computing / Appreciation of domain-specific knowledge	Architecture and Organization	AR, CN, GV	2	2
	Discrete Structures	DS	1	7
	Systems Fundamentals	SF, NC, OS, PL, IM	3	67
	Algorithms and Programming	AL, SDF	8	46
	Platform-based Development	PBD	-	9
	Graphics and Visualization	GV, CN	-	4
	Data Science and Artificial Intelligence	IM, IS	5	78
	Human-Computer Interaction	HCI	-	6
	Social Issues and Professional Practice	SP, IAS	7	23
Project experience	Software Engineering	SE	2	28
Communication and organizational skills	Social Issues and Professional Practice	SP	2	-
			30	270

*Required class hours: The minimum class hours for a required topic are calculated and considered as 28 class hours for 1st semester (2 hours for 1st semester × 14 weeks).

*Optional class hours: Minimum class hours for selectively handling advanced knowledge after teaching Required Topics

*CS2013 Knowledge area: Algorithms and Complexity(AL), Architecture and Organization(AR), Computational Science(CN), Discrete Structures(DS), Graphics and Visualization(GV), Human-Computer Interaction(HCI), Information Assurance and Security(IAS), Information Management(IM), Intelligent Systems(IS), Networking and Communications(NC), Operating Systems(OS), Platform-based Development(PBD), Parallel and Distributed Computing(PD), Programming Languages(PL), Software Development Fundamentals(SDF), Software Engineering(SE), Systems Fundamentals(SF), Social Issues and Professional Practice(SP)

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*Hours: Minimum teaching-learning hours

Competency	Areas	Required Topics	Optional Topics
Technical understanding of computer science / Familiarity with common themes and principles / Appreciation of the interplay between theory and practice /	Architecture and Organization	<ul style="list-style-type: none"> ○ Numerical expressions on computers (0.5 hours) <ul style="list-style-type: none"> -Bits -Bytes -Binary number -Decimal number -Binary notation -Hexadecimal notation ○ Data representation (0.5 hours) <ul style="list-style-type: none"> -Data and metadata -File formats and encoding -Text/binary files 	<ul style="list-style-type: none"> ○ Information theory (2 hours) <ul style="list-style-type: none"> -Information quantitation -Entropy -Entropy encoding

System-level perspective / Problem solving skills / Commitment to life-long learning / Commitment to professional responsibility / Awareness of the broad applicability of computing / Appreciation of domain-specific knowledge		-Text: Unicode -(Digital) Image: RGB, Pixel -(Digital) Sound and music: MIDI -Video ○ Digitalization of analog information (1 hour) -Sampling -Compression -Quantizing -Encoding	
	Discrete Structures	○ Introduction to discrete structures (1 hour) -Truth tables -Logical function -Boolean algebra -Understand basic probability	○ Understand basic set theory and set-theoretic notation (1 hour) ○ Advanced discrete structures -Truth tables (1 hour) -Logical function (1 hour) -Boolean algebra (1 hour) -Understand basic probability (2 hours) ○ Graphs (1 hour)
	Systems Fundamentals	○ Introduction to internal structures and operations of computer (1 hour) -Components of computer systems: Hardware and software (introduction) -Hardware 1. CPU(Architecture) = Processor 2. Memory(=Ram): Hard disk, SD card, USB flash memory USB 3. Storage	○ Advanced internal structures and operations of computer -Von Neumann architecture (1 hour) -Logic circuit (2 hour) -Principles of error correction (2 hours) -Computer commands (2 hours) -Input/Output device (1 hour)
		-	○ Introduction to network (1 hour) [Examples] -Introduction to the internet -Internet connectivity -The web -Protocol 1. Client/Server 2. HTTP 3. Hostname 4. DNS 5. TCP/IP ○ Social networking (1 hour) -SNS ○ Hardware and naming schemes (1 hour)
		-	○ Operating Systems (2 hours) -What is OS? -Why is OS necessary? -Introduction of features of operating systems: Process management, memory management, interrupt management, and other tasks of OS -What is the file system? ○ Real-time OS (1 hour)
		-	○ Parallel processing (2 hours) -Why is parallel processing necessary?

			<ul style="list-style-type: none"> -Instruction level parallelism -SIMD parallelism -Multicore parallelism ○ Distributed processing (2 hours) -Web service -Internet -Domain name -Scalability
		<ul style="list-style-type: none"> ○ Introduction to Web programming language (2 hours) -Why do Programming Languages exist? -Why do we have many Programming Languages? -Roles of programming languages 	<ul style="list-style-type: none"> ○ Advanced programming language (3 hours) -Various programming models -CPUs and machine language -Language processors -Program efficiency -Compiler ○ Program development (3 hours) -Object-oriented design -Top-down design ○ Object-Oriented Programming (OOP) (2 hours) -Objects -Class -Subclasses -Inheritance -Overriding ○ Data types -Primitive data types (ex: number, bool) (6 hour) -Composite data types (ex: record, union, array, list, function, reference) (6 hours) ○ Functional programming -Lambda calculus (4 hours) -Higher-Order functions (4 hours) ○ Advanced programming structures (2 hours) -String manipulation -Assertions ○ Logic programming (2 hours)
		-	<ul style="list-style-type: none"> ○ Various examples of information systems (2 hours) -Planning information systems -Types and uses of information systems -Understanding future IT ○ Databases (3 hours) -Information system hardware and data processing -Development history and roles of databases -Characteristics of operational databases -Social functions of operational systems -Introduction of multidimensional analytical database

			<ul style="list-style-type: none"> -Understanding multidimensional OLAP analysis -Characteristics of data warehouse -Why are databases necessary? -Understanding data quality ○ Data modeling (2 hours) -Network models -Hierarchical model -Introduction to relational databases ○ Database System (2 hours) -SQL and relationship algebra -NoSQL -Normal form and consistency -Trouble recovery ○ SQL (8 hours) -Understanding database language SQL -Relational databases: SQL, Tables -Creating a Database -Querying using SQL -Advanced Querying using SQL -SQL with Python
	Algorithms and Programming	-	<ul style="list-style-type: none"> ○ Algorithm complexity -Criteria for good algorithms (ex: What is Arthur Benjamin's multiplication algorithm? How does it compare to algorithms you know for long multiplication?) (1 hour) -Asymptotic notation (Big O) (1 hour) -Algorithmic complexity (1 hour) (Efficiency of algorithms, Computational Complexity (Time Complexity, Space Complexity)) -Limits of Computation (1 hour): Incomputability ○ Sorting algorithm (3 hours) -Selection sort -Bubble sort -Merge sort ○ Searching algorithm (2 hours) -Linear search -binary search ○ Kinds of algorithm (6 hours) -Greedy algorithm -Divide-and-conquer -Dynamic programming -Backtracking
		<ul style="list-style-type: none"> ○ Computational Thinking (Algorithmic Thinking) (1 hour) 1. Decomposition 2. Abstractions 3. Testing 4. Debugging ○ Introduction to algorithm and programming (1 hour) 	<p>[For courses focused on programming] (31 hours)</p> <ul style="list-style-type: none"> ○ Advanced programming concept I (4 hours) -Basic syntax -Variables -Data types (ex: number, character string) -I/O

		<ul style="list-style-type: none"> -What is computation? 1. What is an algorithm? 2. What is computer program? 3. What is programming? ○ Data Structures (2 hours) [Examples] -Arrays: Arrays of Objects, Built-in Array Functions -Characters -Strings -Numbers -Lists; Linked lists -Queues -Stacks -Dictionary -Tuple -Sets -Trees -Hash table -Sequences (lists, strings, tuple) -Container type (dictionary, tuple, set) -Abstract data structure (FIFO, LIFO, dictionary) -Aliasing ○ Introduction to programming concept I (2 hours) -Basic syntax -Variables -Data types (ex: number, character string) -I/O ○ Introduction to programming concept II (2 hours) -Control Structures (Control flow statements) 1. Sequential processing 2. Conditional branch 3. Iteration 	<ul style="list-style-type: none"> ○ Advanced programming concept II (4 hours) -Control Structures (Control flow statements) 1. Sequential processing 2. Conditional branch 3. Iteration -Conditional statements (2 hours) (Conditionals/Branching/ Selection statements Decision) 1. If-statements 2. Switch -Iteration (2 hours) (loops/loop statements) 1. While loop 2. For loop -Operator (2 hours) 1. Arithmetic Operator 2. Comparison Operator 3. Logical Operator -Functions (4 hours) 1. Function definition 2. Function call 3. Argument 4. parameter 5. Local Variable 6. Global Variable -Recursion (2 hours) -Module (4 hours) -Exceptions (4 hours) ○ Programming development method -Programming style (1 hour) -Use of libraries (practice) (2 hours)
	Platform-based Development	-	<ul style="list-style-type: none"> ○ Overview of platform-based development (1 hours) [Examples] -An overview of architectural styles across multiple platforms including web, mobile, apps, industrial, game, robotics, etc. -Integration of transaction back-end system and front-end web technology in web architecture ○ Front-end web technology (HTML/CSS/JavaScript) -Introduction to HTML (1 hours) [Examples] 1. Version of HTML 2. HTML document structure 3. Body elements 4. About “tags” 5. Building your own web page HTML -Introduction to CSS (1 hours) [Examples] 1. Roles of CSS

			<p>2. Forms of CSS</p> <p>3. Properties of CSS</p> <p>4. Other methods of creating websites</p> <p>-JavaScript (2 hours)</p> <p>1. JavaScript: Basics</p> <p>2. JavaScript: Decisions</p> <p>3. JavaScript: Iteration and arrays</p> <p>4. JavaScript: Functions and events</p> <p>○ Web design</p> <p>-Webpage layout (2 hours)</p> <p>1. Webpage layout</p> <p>2. Layout example: New York Times</p> <p>3. Layout: Washington Post</p> <p>-Responsive web design (2 hours)</p> <p>1. What is Responsive web?</p> <p>2. Using HTML5</p> <p>3. Using CSS3</p> <p>4. Forms</p>
	Graphics and Visualization	-	<p>○ Computer graphics (1 hour)</p> <p>[Examples]</p> <p>-How to compute 'Shading'</p> <p>-What existing 'Umwelt' extensions do humans already enjoy?</p> <p>-Does 'Visualization' qualify as an Umwelt extension?</p> <p>-Why is Good Picture-Making an 'Optimization' process?</p>
		-	<p>○ Examples of modeling (3 hours)</p> <p>[Examples]</p> <p>1. Environmental and social phenomena</p> <p>-Modeling environmental and social phenomena</p> <p>-Predicting market development</p> <p>2. Chemical and physical phenomena</p> <p>-Modeling chemical and physical phenomena</p> <p>-Solving differential equations using Excel</p> <p>-Controlling heat transfer by balancing heating and cooling</p> <p>-Predicting intimate heat transfer</p> <p>3. World of atoms</p> <p>-Modeling the world of atoms</p> <p>-Molecular dynamics predicting 1 picosecond in the future by solving the world of atoms and molecules</p> <p>-Becoming professionals who visualize solid, liquid, and gas states and 'visualize and fascinate' analysis results</p>
	Data Science and Artificial Intelligence	<p>○ Overview of data science (1 hour)</p> <p>-Data science in a nutshell: what and why data science; fundamental principles guiding data science; impact of data science across fields</p>	<p>[For courses focused on data analysis] (26 hours)</p> <p>○ Data mining</p> <p>-What is data analytics? (2 hours)</p> <p>-Data analysis using programming languages (Excel, Python, Map-Reduce, R)</p> <p>1. Data preprocessing (2 hours)</p> <p>1) Descriptive statistics of data</p>

		<p>-Introduction and review of recent developments and application of data sciences</p>	<p>2) Data correlation 3) Data processing: Cleaning, Counting 2. Data similarity (2 hours) 3. Data clustering (2 hours) 4. Association rule discovery (2 hours) 5. Network analysis (2 hours) 6. Text mining (2 hours) -Data analytics applications (Google Analytics, Scientific Data Sets, Open Data, Web Data Services, Data Integration) (2 hours) -Understanding big data processing and analysis technologies (2 hours)</p> <p>○ Web crawling (4 hours)</p> <p>○ Data visualization (4 hours) [Examples] -Basic charts and plots, multivariate data visualization, text rendering -Applications and case studies of and data visualizations -Reporting -Data visualization software: Plotting data in Python: the use of library matplotlib -Principles of visual design, perception and color theory -Examples of effective visualization for diverse types of datasets, e.g. matrices, graphs, trees, scalar fields, vector fields, high-dimensional data, etc. -Annotation in data visualization -One of professional software for data visualization: Tableau, QlikView, Power BI, d3.js, Gephi, Weka, etc.</p>
		<p>○ Overview of artificial intelligence (1 hour) [Examples] -Concept of AI -History of AI -Strong AI, Weak AI -Turing Test -Chinese room -Examples of successful recent AI applications (ex: IBM Watson, Google Self-Driving Cars) -What Makes Something Intelligent? -Limits of AI -Algorithms used in AI (ex: pattern recognition)</p> <p>○ Introduction to machine learning (1 hour) [Examples] -What is learning? -Why have machines learn?</p>	<p>[For courses focused on data analysis] (52 hours) ○ AI principal areas (1 hour) -Reasoning -Knowledge representation</p> <p>○ Advanced machine learning (5 hours) [Examples] -Kinds of machine learning: Regression, Supervised Learning, Unsupervised learning, Reinforcement learning (1 hour) -Writing machine learning programs using Python (2 hours) -Multiple Instance Learning (MIL) technique (2 hours)</p> <p>○ Neural networks (30hours) [Examples] -Overview of neural networks (2 hours)</p>

		<ul style="list-style-type: none"> -Kinds of machine learning: Regression, Supervised Learning, Unsupervised learning, Reinforcement learning o Practice of AI services available (2 hours) [Examples] -AI Creative Services (ex: Google Doodle, Living Archive, Deep Dream Generator) -AI recognizing pictures (ex: AutoDraw, Quick, draw!) -AI Translation Services (ex: Google Translate, NAVER Papago) -AI Search Service (ex: Google Lens, Naver Smart Lens) 	<ul style="list-style-type: none"> -Neural network problem (2 hours) -Perceptron (2 hours) -MLP (Multi-layer perceptron) (2 hours) -Backpropagation (2 hours) -Convolutional neural network (CNN) (3 hours) -Classification (3 hours) -Data Augmentation (3 hours) -Various CNN localizations (CAM) (3 hours) -Segmentation (FCN) (3 hours) -GAN (Generative Adversarial Network) (3 hours) -Intelligent search (2 hours) o Deep learning (2 hours) -Introduction to Deep Learning -Technologies related to deep learning -Deep learning problem -MNIST classification o Computer vision (2 hours) -How can we program a computers to 'see' in 3D? -How Good is 3D Capture? -Is 2D any simpler? Why? -Traditional CV vs. Deep Neural Nets/ Learning -Introduction of computer vision application areas -Introduction of various computer vision applications o Other AI theories (5 hours) [Examples] -Sampling and randomness (1 hour) -Evolutionary algorithms (1 hour) -Natural language understanding: Chatbot (1 hour) -Expert System (1 hour) -Game Theory and Auctions (1 hour) o Robotics (7 hours) -Overview of Robotics (1 hour) -Sensor, Actuator, Module, Input/Output, Communication (2 hours) -Automatic driving: Latest trend, basic information processing, and social tasks of introducing automatic driving of vehicles (2 hours) -Robots: Latest trend of robot research applied to industrial plants and everyday lives, information technologies used in robots, and social tasks of introducing robots (2 hours)
	Human-Computer Interaction	-	<ul style="list-style-type: none"> o User Interface (1 hour) -Definition and functions of interfaces

			<ul style="list-style-type: none"> -GUI; graphical user interface ○ Interaction (2 hours) [Examples] -Gulf of execution -Gulf of evaluation -Affordances, Signifiers - Gulf of execution -Perception, Cognition and the Gulf of evaluation -Perceived causality and the Gulf of evaluation ○ HCI methods (2 hours) [Examples] -User-centered design -Design process – maximizing good ideas -Rapid prototyping -Visual design elements (layout, color, font, labeling) ○ Future of HCI (1 hour) [Examples] -Bret Victor's Brief Rant: What's wrong with this picture? -Michael Nielson's vision – Primitives for thinking -Fei-Fei Li on Human-Centered AI
	Social Issues and Professional Practice	<ul style="list-style-type: none"> ○ Information society and IT (change/evolution) (2 hours) [Examples] -Computer development history (various computers) -Systems and Networks 1. The expanding network 2. And much of the growth is mobile 3. What's wrong with mobile? 4. For better access 5. Internet connectivity -Social problems and how information technologies can solve them: Case study -Computing and Education -Contact points between SNS, GPS, big data and society -Merits and demerits of the Internet (will it accelerate democracy, is the Internet a public space or a community?) ○ Introduction to modern information technologies (1 hour) [Examples] -Sharing Economy -Sharing Model: B2C(Business-to-customer), P2P(Peer-to-Peer) -E-commerce -Digital Marketing -Location-Based Services -Evolving computers (ex: supercomputers, wearable) 	<ul style="list-style-type: none"> ○ AI Algorithmic Bias (4 hours) -The basic methodology of machine learning 1. Features and labels 2. Training procedures and evaluation 3. The problem of interpretability -Sources of bias in algorithmic decision-making 1. Bias in features and labels 2. Bias in training procedures 3. Implications for discrimination law ○ Introduction to information security (3 hours) -Computer security: Examples and mechanisms of security, defense measures, threats, attacks, and system vulnerabilities (2 hours) -Using IT services in a secure manner (1 hour) [Examples] 1. Passwords 2. Using virtual private network (VPN) 3. Secure browsing 4. Securing Wi-Fi connection 5. Using security suite software 6. Configuring personal firewall 7. Junk mail filtering and sorting 8. Email, private mode

		<p>computers, VR, AR, 3D printers, deep learning, quantum computers, IoT (Internet of Things))</p> <ul style="list-style-type: none"> -Digital computing (hardware, software, peopleware) -Networking and communication systems -Data storage technologies -Internet and the Web (technologies, services, applications) -Smart city technologies (ex: Internet-of-things (IoT), big data/data mining, open data, cloud, mobile apps, e-government, artificial intelligence, etc.) -Smart city applications (ex: smart energy, environment, waste, government, community, transportation, smart building/smart homes, public health, safety, etc.) -Various AI technologies and methods (ex: AI applications in medicine/health, fintech, smart city, lawtech, insurtech, etc.) <ul style="list-style-type: none"> ○ Knowledge required to properly handle information in society (1 hour) <ul style="list-style-type: none"> -Basic information about appropriate expression methods and credibility judgment to deliver proper information to others and not misinterpret information from others -Basic knowledge about handling information for adequate decision-making in society -Basic methods of analyzing human behavior in society on the information level ○ Copyright (1 hour) <ul style="list-style-type: none"> [Examples] -Ethical and cultural problems regarding the use of and handling digital information -DRM; Digital Right Management -Digital Watermarking -Illegal reproductions -Boundary between rights and ownership -Open Source Project ○ Privacy (1 hour) <ul style="list-style-type: none"> [Examples] -Values served by privacy 	<ul style="list-style-type: none"> ○ Information system security issues and measures by case studies (2 hours) ○ Information security policies and practices (2 hours) ○ Encryption technologies and applications (3 hours) <ul style="list-style-type: none"> -How to use encryption while transferring data and using mobile data storage devices -How to use password-protection while transferring data and using mobile data storage devices -Symmetric-key Cryptography -Public-key Cryptography (SSL, https) -Electronic Signatures/Digital Signature -Encryption of wireless LAN -Blockchain -PKI (public key infrastructure) -Zero-knowledge -Application in secret calculations and anonymous authentication ○ History of Cryptography (2 hours) ○ Network and security (2 hours) <ul style="list-style-type: none"> -Security basics -Classification of security threats -Internet security -Safety of mutual authentication ○ Cybersecurity (2 hours) <ul style="list-style-type: none"> [Examples] -Cyberspace -Cybercrime (Computing crime) -Cyber law -Cyber ethics -Cyber policy -Cyber Defense -Cyberattack
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Project experience	Software Engineering	<ul style="list-style-type: none"> ○ Team learning (2 hours) -Debates, role plays, group assignments, etc. 	<p>[For courses focused on project activities] (28 hours)</p> <ul style="list-style-type: none"> ○ Project activities -Preparation of project overview -Preparation of project plan -Project concept design -Detailed project design -Project execution (checking progress of each step (major changes, expected effects, improvements)) -Prototyping -Detailed system design and major functions -Project evaluation (activity report, mutual evaluation by team members, progress report, etc.)
Communication and organizational skills	Social Issues and Professional Practice	<ul style="list-style-type: none"> ○ Presentations (2 hours) -Investigation, analysis, discussion, and presentation of social issues 	-