# Computing Handbook 1

Computer Science and Software Engineering

8. Alternating Complexity Classes
9. Circuit Complexity
10. Probabilistic Complexity Classes
11. Quantum Computation
12. Interactive Models and Complexity Classes (Topics 2)
13. Kolmogorov Complexity
14. Research Issues and Summary

**06. Formal Models and Computability**

1. Introduction
2. Computability and a Universal Algorithm (Topics 2)
3. Undecidability (Topics 2)
4. Formal Languages and Grammars (Topics 3)
5. Computational Models (Topics 2)
6. Key Terms

**07. Cryptography**

1. Introduction
2. Private-Key Setting and Private-Key Encryption (Topics 6)
3. Message Authentication Codes (Topics 2)
4. Public-Key Setting and Public-Key Encryption (Topics 4)
5. Digital Signature Schemes (Topics 2)
6. Key Terms

**08. Algebraic Algorithms**

1. Introduction
2. Matrix computations (Topics 5)
3. Polynomial Root-Finding and Factorization (Topics 5)
4. Systems of Nonlinear Equations (Topics 4)
5. Research Issues and Summary
6. Key Terms

**09. Some Practical Randomized Algorithms and Data Structures**

1. Hashing (Topics 3)
2. Sketches (Topics 2)
3. String Matching and Document Similarity (Topics 2)
4. RSA and Primality Testing (Topics 4)
5. Naïve Bayesian Classifier
6. Randomized Greedy Heuristics

**10. Approximation Algorithms and Metaheuristics**

1. Underlying Principles (Topics 4)
2. Impact on Practice
3. Research Issues
4. Summary

**11. Combinatorial Optimization**

1. Introduction
2. Primer on Linear Programming (Topics 7)
3. Large-Scale Linear Programming in Combinatorial Optimization (Topics 3)
4. Integer Linear Programs (Topics 3)
5. Polyhedral Combinatory (Topics 3)
6. Partial Enumeration Methods (Topics 2)
7. Approximation in Combinatorial Optimization (Topics 5)
8. Prospects in Integer Programming
9. Key Terms

**12. Graph Drawing**

1. Introduction
2. Underlying Principles (Topics 3)
3. Graph Drawing Algorithms (Topics 2)
4. Impact on Practice
5. Research issues and Summary
6. Key Terms

**13. Pattern Matching and Text Compression Algorithms**

1. Processing Texts Efficiently
2. String-Matching Algorithms (Topics 6)
3. Two-Dimensional Pattern Matching Algorithms (Topics 2)
4. Suffix Trees (McCreight Algorithm)
5. Suffix Arrays (Topics 4)
6. Alignment (Topics 4)
7. Approximate String Matching (Topics 4)
8. Text Compression (Topics 3)
9. Research Issues and Summary

10. Key Terms

**14. Distributed Algorithms**

1. Introduction
2. Underlying Principles (Topics 4)
3. Impact on Practice (Topics 2)
4. Research Issues (Topics 4)
5. Summary
6. Key Terms

**Part 3 – Architecture and Organization**

**01. Digital Logic**

1. Introduction
2. Overview of Logic
3. Concept and Realization of Digital Gate (Topics 3)
4. Rules and Objectives in Combinational Design (Topics 6)
5. Frequently Used Digital Components (Topics 2)
6. Sequential Circuits (Topics 4)
7. ASICs and FPGAs – Faster, Cheaper, More Reliable Logic (Topics 2)
8. Key Terms

**02. Memory Systems**

1. Introduction
2. Memory Hierarchy
3. Managing the Memory Hierarchy (Topics 2)
4. Caches (Topics 5)
5. Main Memory (Topics 4)
6. Current and Future Research Issues (Topics 2)
7. Summary

**03. Storage Systems**

1. Introduction
2. Magnetic Tapes for Low-Cost Archival Storage
3. Hard Disk Drives (HDDs) (Topics 4)
4. Redundant Arrays of Independent Disks (RAID) (Topics 4)
5. Mirrored Disks or RAIDI (Topics 2)
6. RAID Reliability Analysis (Topics 4)
7. Power Conservation in RAID
8. Miscellaneous RAID Arrays (Topics 3)
9. Storage Area Network and Network Attached Storage
10. Data Deduplication
11. Solid State Disks (SSDs) (Topics 2)
12. Conclusions

**04. High-Speed Computer Arithmetic**

1. Introduction
2. Fixed-Point Number Systems (Topics 2)
3. Fixed-Point Arithmetic Algorithms (Topics 4)
4. Floating-Point Arithmetic (Floating-Point Number Systems)
5. Conclusions

**05. Input / Output Devices and Interaction Techniques**

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2. Interaction Tasks, Techniques, and Devices
3. Composition of Interaction Tasks
4. Properties of Pointing Devices (Topics 9)
5. Discussion of Common Pointing Devices (Topics 7)
6. Feedback and Perception-Action Coupling (Impoverished Physicality)
7. Pointing Facilitation Techniques
8. Keyboards, Text Entry, and Command Input (Topics 6)
9. Modalities of Interaction (Topics 7)
10. Displays and Perception (Properties of Displays and Human Visual Perception)
11. Color Vision and Color Displays (Luminance, Color Specification, and Color Gamut)
12. Information Visualization (Topics 5)
13. Scale in Displays (Topics 3)
14. Force and Tactile Displays
15. Auditory Displays (Topics 3)
16. Future Directions

**06. Performance Enhancements**

1. Introduction
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| 3. Impact on Practice (Topics 12) |
| 4. Research Issues |
| 5. Summary |
| **07. Parallel Architectures** |
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| 2. SISD (Topics 3) |
| 3. SIMD (Topics 2) |
| 4. MISD |
| 5. MIMD |
| 6. High-Performance Computing Architectures (Topics 2) |
| 7. Afterward |
| **08. Multicore Architectures and Their Software Landscape** |
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| 4. Research Issues (Topics 2) |
| 5. Summary |
| **09. DNA Computing** |
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| 3. Characteristic-Based Formulation |
| 4. Maxwell Equations in a Curvilinear Frame |
| 5. Eigenvalues and Eigenvectors |
| 6. Flux-Vector Splitting |
| 7. Finite-Difference Approximation |
| 8. Finite-Volume Approximation |
| 9. Summary and Research Issues |
| **02. Computational Fluid Dynamics** |
| 1. Introduction |
| 2. Underlying Principles (Topics 2) |
| 3. Best Practices (Topics 3) |
| 4. Research Issues and Summary |
| **03. Computational Astrophysics** |
| 1. Introduction |
| 2. Astronomical Databases (Topics 6) |
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| 4. Theoretical Modeling (Topics 13) |
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| **04. Computational Chemistry** |
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| 3. Computation in Chemical Education (Topics 3) |
| 4. Chemical Principles of Absorption Spectroscopy (Topics 2) |
| 5. Computational Medicinal Chemistry (Topics 8) |
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| **05. Computational Biology: The Fundamentals of Sequence-Based** |
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| 4. Complications |
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| **06. Terrain Modeling for the Geosciences** |
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| 3. Computing Contours and Contour Maps |
| 4. Flow Analysis (Topics 4) |
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| 6. Concluding Remarks |
| **07. Geometric Primitives** |
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| 2. Examples in Practice (Topics 3) |
| 3. Underlying Principles of Geometric Representation (Topics 3) |
| 4. Standards |
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| **08. Computer Animation** |
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| 2. Basic Animation Methods (Topics 4) |
| 3. Motion Capture |
| 4. Motion Editing |
| 5. Character Deformations (Topics 5) |
| 6. Facial Animation |
| 7. Behavioral Methods (Autonomous Characters) |
| 8. Crowd Simulation |
| 9. Cloth Animation |
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| 2. Internetworking (Topics 2) |
| 3. WAN Organization (Topics 4) |
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| **02. Routing Protocols** |
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| 2. Forwarding Table (Topics 3) |
| 3. Information in Data Packet (Topics 4) |
| 4. Distributed Routing Protocols (Topics 2) |
| 5. Evolution of Ethernet from Carrier Sense Multiple Access with Collision Detect to Transparent Interconnection |
| **03. Access Control** |
| 1. Introduction |
| 2. Discretionary Access Control (DAC) (Topics 2) |
| 3. Mandatory Access Control (MAC) (Topics 2) |
| 4. Role-Based Access Control (RBAC) (Topics 2) |
| 5. Administration of Authorizations |
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| 7. Conclusions |
| **04. Data Compression** |
| 1. Introduction |
| 2. Entropy and Kolmogorov Complexity (Topics 2) |
| 3. Modeling Data as an iid Sequence (Topics 2) |
| 4. Modeling Data Organization (Topics 2) |
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| 6. Conclusions and Further Reading |
| **05. Localization in Underwater Acoustic Sensor Networks** |
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| 2. Basics of Underwater Acoustic Sensor Networks |
| 3. Related Work |
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| 7. Conclusion and Future Work |
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| 5. Summary |
| **07. Web Search Engines: Practice and Experience** |
| 1. Introduction |
| 2. Search Engine Components and Historical Perspective |
| 3. Crawling and Data Processing (Topics 3) |
| 4. Query Processing and Online Architecture (Topics 4) |

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**02. Thread Management for Shared-Memory Multiprocessors**

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3. Issues in Thread Management (Topics 3)
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**03. Virtual Memory**

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2. Early Virtual Memory Systems (Topics 3)
3. Cache Systems
4. Object Systems
5. Virtual Memory in Other Systems
6. Structure of Virtual Memory (Topics 5)
7. Cache Memories
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12. World Wide Web: A Global Name Space
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**04. Secondary Storage and File systems**

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**05. Performance Evaluation of Computer Systems**

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2. Queueing Theory Basics
3. Analysis of Markovian Models (Topics 7)
4. Analysis of Non-Markovian Queueing Systems (Topics 10)
5. Fork-Join Queueing Systems
6. Queueing Network Models (Topics 7)
7. Page Replacement and Buffer Management
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9. Simulation Modeling and Measurement
10. Conclusions

**06. Taxonomy of Contention Management in Interconnected Distributed Systems**

1. Introduction
2. Request Management Systems
3. Origins of Resource Contentions (Topics 3)
4. Contention Management (Topics 5)
5. Contention Management in Practice (Topics 4)
6. Conclusions and Future Research Directions

**07. Real-Time Computing**

1. Introduction
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**08. Scheduling for Large-Scale Systems**

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2. Background on Scheduling (Topics 3)
3. Underlying Principles (Topics 3)
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5. Case Study: Memory-Aware Scheduling (Topics 4)
6. Case Study: Partitioning Tree Structured Computations (Topics 4)
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| **09. Distributed File Systems** |
| 1. Basics |
| 2. NFS Version 2 (Topics 4) |
| 3. Common Internet File System (Topics 2) |
| 4. DFS |
| 5. NFS version 4 (Topics 2) |
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| **10. Mobile Operating Systems** |
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| 2. Underlying Principles (Topics 3) |
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| **11. Service-Oriented Operating Systems** |
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| 2. Analysis (Topics 2) |
| 3. Derived Operating System Model (Topics 4) |
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| **02. Qualitative Reasoning** |
| 1. Introduction |
| 2. Qualitative Representations (Topics 4) |
| 3. Space and Shape (Compositional Modeling, Domain Theories, and Modeling Assumptions) |
| 4. Qualitative Reasoning Techniques (Topics 7) |
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| **03. Machine Learning** |
| 1. Introduction |
| 2. Overview of the Learning from Date Process |
| 3. Supervised Learning (Topics 7) |
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| **04. Explanation-Based Learning** |
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| 2. Underlying Principles |
| 3. Practice |
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| 5. Summary |
| **05. Search** |
| 1. Introduction |
| 2. Uninformed Search Methods (Topics 2) |
| 3. Heuristic Search Methods (Topics 3) |
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| 7. Most Recent Developments |
| **06. Planning and Scheduling** |
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| 2. Underlying Principles (Topics 2) |
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| 5. Summary |
| **07. Natural Language Processing** |
| 1. Introduction |
| 2. Underlying Principles (Topics 4) |
| 3. Best Practice: Applications and Outcomes (Topics 5) |
| 4. Research Issues (Topics 4) |
| 5. Summary |
| **08. Understanding Spoken Language** |
| 1. Introduction |

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| 2. Impact on Practice |
| 3. Underlying Principles (Topics 4) |
| 4. Research Issues |
| 5. Summary |
| **09. Neural Networks** |
| 1. Introduction |
| 2. Representation (Topics 5) |
| 3. Learning From Data (Topics 7) |
| 4. Graphical Models |
| **10. Cognitive Modeling** |
| 1. Introduction |
| 2. Underlying Principles (Topics 4) |
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| 5. Summary |
| **11. Graphical Models for Probabilistic and Causal Reasoning** |
| 1. Introduction |
| 2. Historical Background |
| 3. Bayesian Networks as Carriers of Probabilistic Information (Topics 4) |
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| 5. Counterfactuals (Topics 3) |