



Academia de Studii Economice
Departamentul de Informatică și Cibernetică Economică

Calea Dorobanți, 15-17, Sector 1, București, 010552 (camera 2314)

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Contest Topics for Professor
Position 29, year 2024-2025, semester 1

Disciplines:

- **Data Structures**
- **Secure Application Programming**
- **Artificial Intelligence in IT Security Systems**

Data Structures

1. Standard and software developer-defined data types. Pointers. Models and requirements for defining, initializing, using and readability of data in the source code program.
2. Contiguous data structures. Quality indicators for using the memory. Memory segmentation at run-time.
3. Non-Contiguous dynamic data structures: simple linked list and double linked list – definition, allocation, and use.
4. Stack and queue data structures: definition, allocation, and use.
5. Hash table data structures: characteristics, hash functions, operations, collision solving mechanisms.
6. Heap data structure: definition, allocation, and use. Priority queues.
7. Graph data structure: characteristics, definition, allocation, and use. Graph traversal algorithms.
8. Tree data structures: arbitrary tree structures and binary trees: definition, allocation, and use. Structure trees: characteristics, implementation, and operations. Structure trees: characteristics, implementation, and operations.
9. Tree data structures: binary search tree – definition, allocation, and use.
10. Balanced trees and self-balancing search trees: balanced binary trees, AVL trees – definition, characteristics, and operations.

Bibliography

1. Marius Popa, Cristian Ciurea, Mihai Doinea, Alin Zamfiroiu, Structuri de date. Teorie și practică, Editura ASE, București, 2023
2. Erik Demaine, Advanced Data Structures, 2003, http://courses.csail.mit.edu/6.897/spring03/scribe_notes
3. Ion Ivan, Marius Popa, Paul Pocatilu (coordonatori), Structuri de date, Editura ASE, București, 2008



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4. Ion Smeureanu, Marian Dârdală, Programarea în limbajul C/C++, Editura CISON, București, 2004
5. Stephen Kochan, Programming in C, 4th Edition, Addison-Wesley Professional, 2014

Secure Application Programming

1. Data types, variables pointer, use stack and heap memory in C/C++.
2. Functions: mechanisms to pass parameters, pointers to functions in C/C++.
3. Files: types, access to data stored on disk, processing data stored in files in C/C++.
4. Build and use static and dynamic libraries in C/C++.
5. Classes: defining, structuring, construction and destruction of objects, the pointer this in C++, copy constructor and operator overloading in C++, derivation, and polymorphism in C++, building class template and use Standard Template Library in C++.
6. Develop crypto applications using 3rd party crypto libraries in C/C++ (OpenSSL, LibTomCrypt, mbedtls).
7. OpenSSL: compile and use in cryptographic applications in C/C++.
8. OpenSSL: hash function to compute message digest (SHA family algorithms), symmetric cryptographic algorithms (AES), and asymmetric ones (RSA, ECC) – create, validate, and use public and private keys, digital signatures (RSA, ECC) – create and use digital RSA-based and ECDSA signatures.
9. OpenSSL: structure and implementation of digital certificate in C/C++ using OpenSSL.

Bibliography

1. Bjarne Stroustrup, The C++ Programming Language, Addison-Wesley, 2014
2. Richard Grimes, Beginning C++ Programming, Packt Publishing, 2017
3. Michael Welschenbach, Cryptography in C and C++, Apress, 2005
4. Ion Ivan, Cristian Toma, Informatics Security Handbook - 2nd Edition, ASE Publishing House, 2009
5. OpenSSL Documentation, 2023, <https://www.openssl.org>
6. LibTomCrypt, 2023, <https://www.libtom.net/LibTomCrypt>

Artificial Intelligence in IT Security Systems

1. Design of Artificial Intelligence models. Machine learning (ML-Machine Learning) as a subset of the field of Artificial Intelligence. Types of ML algorithms: Supervised, Unsupervised and Knowledge Reinforcement.
2. Supervised ML algorithms: Linear Regression, Decision Trees, Support Vector Machine (SVM).
3. Performance metrics for classification based on ML algorithms: Confusion Matrix, Accuracy, Precision, Sensitivity.



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4. Performance metrics for the inference process: Mean Square Error, Coefficient of determination.
5. Neural Networks (Deep Learning). The concept of neuron and perceptron. Activation functions. The Feed-forward process and the Backpropagation learning algorithm for a neural network.
6. Algorithms for Unsupervised Classification based on unlabeled data: Clustering using K-means or DBSCAN, Principal Components Analysis.
7. Algorithms for Strengthening Knowledge based on interaction with the environment: Q-Learning, Deep Q Networks, Proximal Policy Optimization.
8. Neural Networks Graph. Classification of sub-graphs. Entity classification (clustering, entity recognition), Link prediction between nodes, Knowledge extraction (reasoning). Ontologies.

Bibliography

1. Aurelien Geron, Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow, 3rd Edition, O'Reilly Media Inc., 2022
2. Joel Grus, Data Science from Scratch, O'Reilly Media Inc., 2022
3. Stuart Russel, Peter Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Hall, 2020