



Syllabus

Course Program



Evolutionary programming

Specialty

125 Cybersecurity and information protection

Institute

Educational and Scientific Institute of Computer Science and Information Technology

Educational program

Cybersecurity

Department

Cybersecurity (328)

Level of education

Bachelor's level

Course type

Profile training, Selective

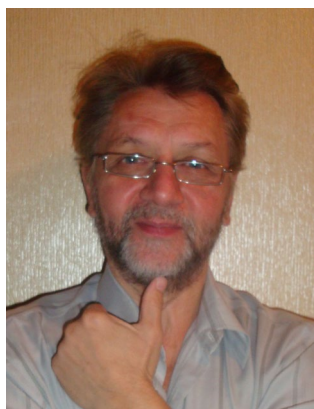
Semester

7

Language of instruction

English

Lecturers and course developers

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Doctor of technical sciences, professor of the cyber security department of National Technical University "Kharkiv Polytechnic Institute".

Author of more than 200 scientific and educational and methodological works. Academic supervisor for protected candidate theses, guarantor of the educational and professional program of the second (master's) level of higher education. Leading lecturer in the disciplines: "Mathematical foundations of cryptology and cryptanalysis", "Data structures", "Industrial and office espionage", "Digital forensics", for undergraduate and graduate students, Section "Methodology of scientific and pedagogical activity in the sciences of cyber protection" for postgraduate students.

[More about the lecturer on the department's website](#)

General information

Summary

The discipline "Evolutionary programming" covers the basics and practical aspects of using evolutionary algorithms to solve complex optimization problems. Evolutionary programming (EP) is part of a broader class of algorithms inspired by natural processes, in particular the theory of evolution, based on the principles of natural selection and genetic mutation.

Course objectives and goals

The discipline provides students with the necessary knowledge and skills to develop and implement evolutionary algorithms, which makes them prepared to solve practical problems in the field of computer science, information technology, and engineering. The course promotes the development of analytical thinking and a creative approach to solving complex problems, which are important in the conditions of a rapidly changing technological environment.

Format of classes

Lectures, laboratory classes, consultations, self-study. Final control – credit test.

Competencies

- GC-1. Ability to apply knowledge in practical situations.
- GC-2. Knowledge and understanding of the domain and understanding of the profession.
- GC-3. Ability to communicate professionally in both spoken and written national and foreign languages.
- GC-4. Ability to identify, state and solve problems in a professional manner.
- GC-5. Ability to search, process and analyze information.
- PC-2. Ability to use information and communication technologies, modern methods and models of information security and/or cyber security.
- PC-3. Ability to use software and software-hardware complexes of means of information protection in information and telecommunication (automated) systems.
- PC-8. Ability to carry out incident management procedures, conduct investigations, provide them with an assessment.
- PC-11. Ability to monitor the processes of functioning of information, information and telecommunication (automated) systems in accordance with the established policy of information and/or cyber security.
- PC-12. Ability to analyze, identify and evaluate possible threats, vulnerabilities and destabilizing factors to the information space and information resources in accordance with the established policy of information and/or cyber security.

Learning outcomes

- LO-1. Apply knowledge of state and foreign languages in order to ensure the effectiveness of professional communication;
- LO-2. Organize own professional activity, choose optimal methods and ways of solving complex specialized tasks and practical problems in professional activity, evaluate their effectiveness;
- LO-3. Use the results of independent search, analysis and synthesis of information from various sources for the effective solution of specialized tasks of professional activity.
- LO-4. Analyze, argue, make decisions when solving complex specialized tasks and practical problems in professional activity, which are characterized by complexity and incomplete determination of conditions, be responsible for the decisions made.
- LO-5. Adapt under the conditions of frequent changes in the technologies of professional activity, to predict the final result.
- LO-6. Critically understand the main theories, principles, methods and concepts in education and professional activity.
- LO-7. Act on the basis of the legislative and regulatory framework of Ukraine and the requirements of relevant standards, including international ones in the field of information and/or cyber security.
- LO-8. Prepare proposals for regulatory acts on ensuring information and/or cyber security.
- LO-9. Implement processes based on national and international standards for detection, identification, analysis and response to information and/or cyber security incidents.
- LO-10. Perform analysis and decomposition of information and telecommunication systems.
- LO-11. Perform analysis of connections between information processes on remote computer systems.
- LO-12. Develop threat and intruder models.
- LO-13. Analyze projects of information and telecommunication systems based on standardized technologies and data transmission protocols.
- LO-14. Solve the task of protecting programs and information processed in information and telecommunication systems by hardware and software tools and evaluate the effectiveness of the quality of the decisions made.
- LO-15. Use modern hardware and software of information and communication technologies.
- LO-16. Implement complex information security systems in the automated systems (AS) of the organization (enterprise) in accordance with the requirements of regulatory and legal documents.
- LO-17. Ensure the processes of security and functioning of information and telecommunication (automated) systems based on practices, skills and knowledge, regarding structural (structural-logical) schemes, network topology, modern architectures and models of security of electronic information resources with a reflection of relationships and information flows, processes for internal and remote components.
- LO-18. Use software and software-hardware complexes for the security of information resources.

- LO-19. Apply theories and methods of protection to ensure information security in information and telecommunication systems.
- LO-20. Ensure the functioning of special software to protect information from destructive software influences, destructive codes in information and telecommunication systems.
- LO-21. Solve tasks of provision and support (including: review, testing, accountability) of the access control system according to the stated security policy in information and telecommunication (automated) systems.
- LO-22. Solve the management procedures of identification, authentication, authorization of processes and users in information and telecommunication systems according to the established policy of information and/or cyber security.
- LO-23. Implement measures to prevent unauthorized access to information resources and processes in information and telecommunication (automated) systems.
- LO-24. Solve the problems of managing access to information resources and processes in information and telecommunication (automated) systems based on access management models (mandatory, discretionary, role-based).
- LO-25. Ensure the introduction of accountability of the access management system to electronic information resources and processes in information and telecommunication (automated) systems using event registration logs, their analysis and stated protection procedures.
- LO-26. Implement measures and ensure the implementation of processes of prevention of unauthorized access and protection of information, information and telecommunication (automated) systems based on the reference model of interaction of open systems.
- LO-27. Solve problems of data flow protection in information and telecommunication (automated) systems.
- LO-28. Analyze and evaluate the effectiveness and level of security of resources of various classes in information and telecommunication (automated) systems during tests in accordance with the established policy of information and/or cyber security.
- LO-29. Evaluate the possibility of realization of potential threats of information processed in information and telecommunication systems and the effectiveness of the use of complexes of protection means under the conditions of realization of threats of various classes.
- LO-30. Assess the possibility of unauthorized access to elements of information and telecommunication systems.
- LO-31. Apply protection theories and methods to ensure the security of elements of information and telecommunication systems.
- LO-32. Solve the tasks of managing the processes of restoring the regular functioning of information and telecommunication systems using backup procedures in accordance with the stated security policy.
- LO-33. Solve the problems of ensuring the continuity of business processes of the organization on the basis of risk management theory.
- LO-34. Participate in the development and implementation of an information security and/or cyber security strategy in accordance with the goals and objectives of the organization.
- LO-35. Solve the tasks of providing and supporting complex information security systems, as well as countering unauthorized access to information resources and processes in information and information-telecommunication (automated) systems in accordance with the stated policy of information and/or cyber security.
- LO-41. Ensure the continuity of the event and incident logging process based on automated procedures.
- LO-42. Implement processes of detection, identification, analysis and response to information and/or cyber security incidents.
- LO-43. Apply national and international regulatory acts in the field of information security and/or cyber security to investigate incidents.
- LO-44. Solve the problems of ensuring the continuity of the organization's business processes on the basis of risk management theory and the stated information security management system, in accordance with national and international requirements and standards.
- LO-45. Apply early classes of information security and/or cyber security policies based on risk-based access control to information assets.
- LO-46. Analyze and minimize the risks of information processing in information and telecommunication systems.
- LO-47. Solve the problems of protection of information processed in information and telecommunication systems using modern methods and means of cryptographic protection of information.

LO-48. Implement and maintain intrusion detection systems and use cryptographic protection components to ensure the required level of information security in information and telecommunications systems.

LO-49. Ensure the proper functioning of the monitoring system of information resources and processes in information and telecommunication systems.

LO-50. Ensure the functioning of software and software-hardware complexes for detecting intrusions of various levels and classes (statistical, signature, statistical-signature).

LO-51. Maintain operational efficiency and ensure configuration of intrusion detection systems in information and telecommunication systems.

LO-52. Use tools for monitoring processes in information and telecommunication systems.

LO-53. Solve problems of software code analysis for the presence of possible threats.

LO-54. Be aware of the values of a civil (free democratic) society and the need for its sustainable development, the rule of law, the rights and freedoms of a person and a citizen in Ukraine.

Student workload

The total volume of the course is 120 hours (4 ECTS credits): lectures - 32 hours, laboratory classes - 16 hours, self-study - 72 hours.

Course prerequisites

"Probability theory" and "Mathematical statistics", "Basics of programming".

Features of the course, teaching and learning methods, and technologies

In the course of teaching the discipline, the teacher uses explanatory-illustrative (informational-receptive) and reproductive teaching methods. Presentations, conversations, and master classes are used as teaching methods aimed at activating and stimulating the educational and cognitive activities of applicants.

Program of the course

Topics of the lectures

Topic 1. Introduction to evolutionary programming.

Basic Principles of Evolutionary Programming: Biological Metaphor, Adaptation, and Evolution. Differences between evolutionary programming and genetic algorithms. The history of the development of evolutionary programming: key stages and scientists.

Topic 2. Genetic programming.

Structure of individuals. Stages of the genetic programming process. Methods of mutation.

Topic 3. Evolutionary strategies.

Definition and features of evolutionary strategies. Differences between evolutionary strategies and genetic programming. Synergy: Using Evolutionary Strategies in Genetic Programming.

Topic 4. Evolutionary programming.

The main components of evolutionary programming. Evolutionary algorithms for optimization. Comparison of evolutionary programming with other methods.

Topic 5. Machine learning.

Machine learning algorithms.

Topic 6. Swarm algorithms.

Types of swarm algorithms. Swarm optimization algorithm. Hybridization of swarm algorithms. Adaptation of swarm algorithms.

Topic 7. Ant algorithms.

Ant colony algorithm. Algorithm of an artificial colony of bees. Comparison of swarm algorithms with other methods.

Topic 8. Immune algorithms.

Main components. Methods of mutation and selection in immune algorithms. Rating. Application. Adaptive immune algorithms.

Topic 9. Algorithms inspired by inanimate nature.

Physical algorithms. Algorithms based on chemical processes. Algorithms based on geographical and natural processes. Algorithms based on thermodynamic principles. Gravitational algorithms. Algorithms based on analytical methods. Practical applications of algorithms inspired by inanimate nature.

Topics of the workshops

Not provided for in the curriculum.

Topics of the laboratory classes

Topic 1. Encoding \ decoding of individuals. Individual assessment function. Population formation. Construction of an iterative process.

Topic 2. Application of the algorithm for solving a system of nonlinear equations.

Topic 3. Programming algorithms of the roulette method and smart weights.

Topic 4. Programming linear and power scaling algorithms.

Topic 5. Programming real-valued genetic algorithms.

Topic 6. Programming algorithms with dynamic population size.

Topic 7. Programming algorithms for the transport problem.

Topic 8. Programming and testing of the algorithm for the transportation problem.

Topic 9. Programming the algorithm for solving an integral equation of the first kind.

Topic 10. Programming the presentation of an individual in the form of a tree.

Topic 11. Programming the algorithm for the problem of symbolic regression.

Topic 12. Programming the island model of genetic algorithms

Topic 13. Programming various stopping criteria of genetic algorithms.

Topic 14. Assessment of convergence of genetic algorithms.

Self-study

A student's independent work is one of the forms of organization of learning, the main form of mastering educational material in free time from classroom training. During independent work, students study lecture material, do individual homework, prepare for tests, tests and exams. Students are also recommended additional materials (videos, articles) for self-study and analysis.

Non-formal education

Within the framework of non-formal education, according to the relevant Regulation (<http://surl.li/pxssv>), the educational component or its individual topics may be taken into account in the case of independent completion of professional courses/trainings, civic education, online education, vocational training, etc.

Subjects are not considered for this component in case of successful completion of the courses.

Course materials and recommended reading

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Assessment and grading

Criteria for assessment of student performance, and the final score structure

Points are awarded according to the following ratio:

- laboratory work: 40% of the semester grade;
- independent work: 10% of the semester grade;
- control work: 10% of the semester grade;
- credit test: 40% of the semester grade.

Grading scale

Total points	National	ECTS
90–100	Excellent	A
82–89	Good	B
75–81	Good	C
64–74	Satisfactory	D
60–63	Satisfactory	E
35–59	Unsatisfactory (requires additional learning)	FX
1–34	Unsatisfactory (requires repetition of the course)	F

Norms of academic integrity and course policy

The student must adhere to the Code of Ethics of Academic Relations and Integrity of NTU "KhPI": to demonstrate discipline, good manners, kindness, honesty, and responsibility. Conflict situations should be openly discussed in academic groups with a lecturer, and if it is impossible to resolve the conflict, they should be brought to the attention of the Institute's management.

Regulatory and legal documents related to the implementation of the principles of academic integrity at NTU "KhPI" are available on the website: <http://blogs.kpi.kharkov.ua/v2/nv/akademichna-dobrochesnist/>

Approval

Approved by

Date, signature

28.08.2024

Head of the department

Serhii YEVSEIEV

Date, signature

28.08.2024

Guarantor of the educational program

Serhii YEVSEIEV