FACULTATEA de MATEMATICĂ și INFORMATICĂ **DEPARTAMENTUL de INFORMATICĂ**

TEME PROPUSE PENTRU LUCRĂRI DE DISERTAȚIE

PROGRAME DE MASTER IN DOMENIUL INFORMATICĂ

AN UNIVERSITAR 2020-2021

Petcu Dana (Dana.Petcu@e-uvt.ro)

Nr. crt.	Denumire temă	Descriere temă	Specializare IACD, AIDC, IS, BigData, BioInf, SC
1	Context-aware adaptation techniques for streaming applications in dynamic networks	Mechanism for adaptation of streaming content according to context information should be investigated.	AIDC, BigData, IACD, IS
2	Resource allocation in Fog-Edge-Cloud continuum	Fog/edge resources are typically resource-constrained, heterogeneous, and dynamic compared to the cloud, thereby making resource allocation an important challenge. The current mechanisms are application dependent. A study is requested in the case of streaming applications.	AIDC, BigData, IACD, IS
3	Transprecision computing application for Internet of Things	Evaluate how the reduced precision version better fits the use case of limited-resources platforms, such as wearable devices	AIDC, BigData, IACD, IS
4	Transpecision computing application in machine learning	Evaluate how the reduced precision version can improve the response time of machine learning mechanisms.	AIDC, BigData, IACD, IS
5	Stream-processing application monitoring	Developing and evaluating a continuous monitoring system which can measure precision and energy consumption of a stream-processing application	AIDC, BigData, IACD, IS
6	Mechanism for tuning transprecision algorithms	Experimenting with a wide range of optimization techniques in the context of transprecision algorithms	AIDC, BigData, IACD, IS

Gabriel Istrate (gabriel.istrate@e-uvt.ro)

Nr. crt.	Denumire temă	Descriere temă	Specializare IACD, AIDC, IS, BigData, BioInf, SC
1.	Advanced topics in algorithms. (max. 2)	*Students will undertake, based on discussions with the coordinator, the implementation, experimental evaluation and benchmarking of some recent algorithms from the scientific literature.* *Desired abilities include familiarity with programming (C++, Python), as well as the desire/ability to read, based on coordinator guidance, recent papers from the scientific literature (written in English).*	IACD, AIDC
3.	Methods for the mining and analysis of social networks.	*Students will develop methods for the analysis and mining of information networks. The setting we have in min dis that of scientific collaboration networks, such as DBLP. Questions one may answer by such analysis could be:* - *What are the communities and central actors in social networks ?* - *How can one measure interdisciplinarity in scientific interests ?* - *How much the centrality of a given node is due to its association with other ''central'' authors ?*	IS, AIDC
4.	A toolkit for algorithmic coalitional game theory.	*Students will implement a toolkit for algorithmic coalitional game theory, including:* - *Methods to specify coalitional games* - *Methods to compute and test various solutions to coalitional games (Shapley value, Banzhaf value, nucleolus)* *A sample computation displaying these methods will be realized.*	IS, IACD, AIDC, BigData
5	Teme propuse de studenti (max. 1)	*Studentii sunt invitati sa propuna teme de studiu pentru lucrarea de disertatie.*	IACD, AIDC, IS, BigData, BioInf, SC

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Nr. crt.	Denumire temă	Descriere temă	Specializare IACD, AIDC, IS, BigData, BioInf, SC
1	Tehnici de clasificare multi-etichetă pentru predicția rezistenței antimicrobiene / Multi-label Classification for Antimicrobial Resistance Prediction	*Context:* The antimicrobial resistance - AMR (i.e. resistance of bacteria to antibiotics) can be induced by some specific genes but some genes can induce resistance to several antibiotics. This suggest that AMR prediction can be interpreted as a multi-label classification (a classification task for which an input *Aim:* (1) AMR data selection and processing; (2) Design and implementation of a multi-label classification algorithms (e.g. in Python or R) *References:* 1. Aytan-Aktug et al, Prediction of Acquired Antimicrobial Resistance for Multiple Bacterial Species Using Neural Networks, 2020, https://msystems.asm.org/content/5/1/e00774-19 2. D. Heider, Multilabel classification for exploiting cross-resistance information in HIV-1 drug resistance prediction, 2013 3. J. Read, Deep Learning for Multi-label Classiffication, 2014	Bioinformatică, Big Data (2 students: - data processing and interpretation of the results - implementation of multi-label classification algorithms)
2	Rețele de asociere pentru analiza datelor referitoare la rezistența antimicrobiană / Association Networks for Antimicrobial Resistance Data Analysis	*Context:* An analysis of antimicrobial resistance (AMR) mechanisms reveals different types of associations both between antibiotics and factors inducing AMR. Constructing association networks and extracting relevant patterns from them can be useful in understanding the mechanisms behind AMR. *Aim:* (1) exploratory analysis of AMR data, (2) Adapt/implement a software tool (e.g. in R) for association networks construction and for identification of patterns in the network *References:* 1. *K. Zawack*, Inferring the interaction structure of resistance to antimicrobials, 2019 https://pubmed.ncbi.nlm.nih.gov/29559109/ 2. *C. Lo*, MPLasso: Inferring microbial association networks using prior microbial knowledge, 2017,https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1005915 3. C. Cazer, Shared Multidrug Resistance Patterns in Chicken-Associated Escherichia coli Identified by Association Rule Mining, 2019, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6473086/	Bioinformatică, Big Data (2 students: - data processing and interpretation of the results - implementation the network analysis tool)

3	Design and Comparative Study of Hybrid Metaheuristics / Proiectarea și analiza comparativă a metaeuristicilor hibride	*Context:* Currently there are many meta-heuristics but each one has some limits, thus they are not effective/ efficient for all types of problems. Therefore combining different techniques might lead to an effective hybrid approach. Various hybridization have been proposed but a systematic study based on the characteristics of a set of metaheuristic would be useful for practitioners. *Aim:* implement a software platform to facilitate the hybridization of different population-based metaheuristics and conduct a comparative study for a practical optimization problem (e.g. optimal wind-turbine placement in wind farms). *References:* 1. C.Blum, G. Raidl, Hybrid Metaheuristics – Powerful Tools for Optimization, Springer 2016 2. E. Amaya et al, Memetic and Hybrid Metaheuristic Algorithms, 2015 - https://www.researchgate.net/publication/283807925_Memetic_and_Hybrid_Evolutionary_Algorithms 3. E. Scott, S. Luke, ECJ at 20: Toward a General Metaheuristics Toolkit, GECCO 2019	AIDC, IACD
4	Evolutionary Design of Deep Neural Networks / Proiectarea evolutivă a rețelelor neuronale cu multe nivele	*Context:* the performance of (deep) neural networks (DNN) depends on their architecture and identifying the appropriate architecture is a tedious task. The idea of using evolutionary algorithms (EA) in neural network design is not new but their use in the context of DNN is limited, mainly because the use of traditional EA is computationaly costly. *Aim:* study various approaches to evolve DNN architectures an illustrate the performance for a task at your choice (e.g. image of data classification) *References:* 1. Y. Sun, B. Xue , M. Zhang and G. Yen - Evolving Deep Convolutional Neural Networks for Image Classification, IEEE TRANSACTIONS ON EVOLUTIONARY COMPUTATION, VOL. 24, NO. 2, APRIL 2020 2. R. Miikulainen et al – Evolving Deep Neural Networks - https://arxiv.org/pdf/1703.00548.pdf, 2017 3. NEAT – NeuroEvolution Augmenting Topologies - https://www.cs.ucf.edu/~kstanley/neat.html, https://neat-python.readthedocs.io/en/latest/neat_overview.html	AIDC, IACD

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Nr. crt.	Denumire temă	Descriere temă	Specializare IACD, AIDC, IS, BigData, BioInf, SC
1-3	Medii pentru dezvoltare de software în cloud. Studiu de caz.	Se vor studia medii pentru dezvoltare de software din domeniul PaaS și se va analiza în ce măsură oferă acestea soluții următoarelor probleme importante din dezvoltarea de software : instalare cod în context de producție, actualizări în timp real fără shutdown, monitorizarea resurselor folosite, facilități de depanare și auditare aplicație într-un mod independent de limbaj și platformă, soluție consistentă și de încredere pentru procesul de dezvoltare în ansamblu, nu doar pentru anumite etape ale acestuia. Exemple: Cloud9 IDE, Eclipse Che, Eclipse Orion, Koding.	IS
4-7	IBM Garage Method for Cloud. Crearea unui toolchain.	Se va studia și analiza metodologia IBM Garage. Se vor selecta zone de interes și soluții aferente acestora pentru a defini bune practici pentru utilizarea de către o firmă fictivă. https://www.ibm.com/garage/method/cloud/	IS
8	Continous delivery practice. Definire și creare toolchain.	Se va organiza activitatea unei firme fictive pentru a aplica practica de livrare continuă. Se va defini și crea un toolchain corespunzător. https://cloud.ibm.com/docs/ContinuousDelivery	IS
9-12	Arhitecturi cu microservicii. Studiu de caz.	Se va proiecta o aplicație în arhitectură cu microservicii și se va experimenta și compara instalarea ei în două soluții cloud diferite.	IS

Marc Eduard FRÎNCU (marc.frincu@e-uvt.ro)

Nr. crt.	Denumire temă	Descriere temă	Specializare IACD, AIDC, IS, BigData, BioInf, SC
1	Studiu comparativ eficiență tehnici de predicție pe diverși algoritmi paraleli de analiză Big Data pe mașini virtuale în cloud vs. mașini fizice locale.	Descriere: *Eficiența algoritmilor de predicție depinde printre altele și de tipul datelor de intrare. Studenții vor analiza pornind de la seturi de date reale eficiența a diferiți algoritmi paraleli a predicției pe date istorice în OpenMP și CUDA pe Google Cloud și pe mașini locale.* Limbaje: *C/C++* API-uri: *OpenMP, CUDA* Număr studenți: *1+*.	IACD, AIDC, BigData

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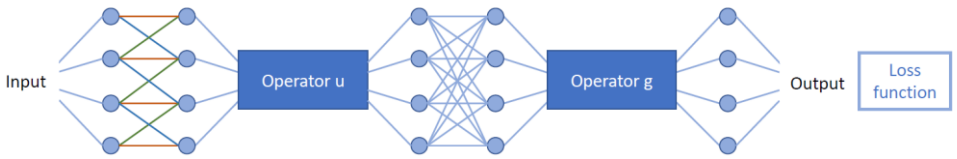
Nr. crt.	Denumire temă	Descriere temă	Specializare IACD, AIDC, IS, BigData, BioInf, SC
1.	Programare declarativa cu rationament aproximativ	*O metoda intens investigata de rationament aproximativ este cea bazata pe relatii de similaritate: relatia de egalitate este inlocuita cu cea de similaritate, care este o relatie fuzzy reflexiva, simetrica si tranzitiva. Scopul acestei teme este de a implementa un algoritm de rezolvare a constrangerilor pentru relatii de similaritate, care sa faciliteze programarea declarativa aproximativa.*	IACD, AIDC
2.	Selection strategies for matching with sequence variables	*Sequence variables are an novel feature of modern declarative programming: they are placeholders for a sequences of 0 or more elements. Programs specified with sequence variables are concise and easy to understand, but they indicate nondeterministic computations, because matching is not unique. This problem can be eliminated by implementing strategies to select a particular matcher. The goal is to study various selection strategies, implement them, and identify applications where they are useful. The investigation will be carried out in Mathematica, a state-of-the-art system for technicla computing, which includes support for rule-based programming and matching with sequence variables.*	IS, AIDC

3.	Programming with anti-rules. Applications.	*Anti-patterns are a natural extension of the notion of pattern with a unary complement operator denoted by* ***Not****. The anti-patterns produced by applying the complement operator to a pattern describe negative features, that is, features that should not be satisfied by some part of the term. The expressive power of anti-patterns becomes much more interesting when anti-patterns are nested inside each other. We propose the notion of anti-rule as a natural generalization of the notion of rewrite rule, by having an antipattern to their left-hand side. To make things work correctly, we will develop algorithms.* *The goal is to implement a rule-based programming language with anti-rules, which allows to reason and work with both positive and negative characterizations of objects.*	IS, IACD, AIDC
4	Teme propuse de studenti (max. 2)	*Studentii sunt invitati sa propuna teme de studiu pentru lucrarea de disertatie.*	IACD, AIDC, IS, BigData, BioInf, SC

Onchis Darian (darian.onchis@e-uvt.ro)

Nr. crt.	Denumire temă	Descriere temă	Specializare IACD, AIDC, IS, BigData, BioInf, SC
1.	Algoritmi XAI de inteligență artificială explicabilă	Utilizarea pe seturi de date și îmbunătățirea algoritmilor LIME, SHAP, Anchors, DeepLift, DeepTaylor, GradCAM etc. Vezi website-ul pixelatus.com pentru exemple.	Toate
2.	Învățarea automată cu operatori cunoscuți	Dezvoltare rețele neuronale de deep learning după următorul tipar: 	Toate
3.	Distilarea cunoștințelor în învățarea automată	Colaborare cu CEA Paris pentru dezvoltarea unei noi metode de compresie a modelului de învățare automată în care un model mic este instruit pentru a imita un model pre-instruit, mai mare.	Toate

4.	Procesare bio-acustică cu rețele neuronale	Folosirea algoritmilor de prelucrarea de semnal ie. mel-spectogramă și a rețelelor neuronale pentru analiza acustică a semnalelor biologice.	BioInf, IS, AIDC, IACD
5.	Analiza avansată a secvențelor în bioinformatică	Analiza secvențelor de ARN viral e.g. SARS-COV2.	BioInf, IS, IACD

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Nr	Tema	Detalii	Obs
1	Applications of Groebner Bases	The method of Groebner bases is an algorithmic method in multivariate polynomial rings, introduced by Bruno Buchberger in 1965. It has numerous applications in polynomial ideal problems (ideal membership, ideal inclusion), solving systems of polynomial equations, etc. Groebner bases proved useful in many domains: algebraic geometry, functional analysis, coding theory, cryptography, program verification, symbolic summation, theorem proving, combinatorics, graph theory. The algorithm is implemented in many computer algebra systems (Mathematica, Maple, CoCoA, Macaulay, Singular, etc.). The purpose of this thesis is to explore possible applications of Groebner bases (theorem proving in geometry, solving systems of equations, etc.). Previous knowledge: logic, mathematical thinking, algebra, computer algebra systems, programming (C++, C, or Mathematica, Maple, etc).	Licenta, dizertatie
2	Logical Frameworks	A logical framework is a formal meta-language for deductive systems. The primary tasks supported in logical frameworks to varying degrees are * specification of deductive systems, * search for derivations within deductive systems, * meta-programming of algorithms pertaining to deductive systems, * proving meta-theorems about deductive systems. The purpose of thesis is the study of the formalism and its applications.	Licenta, dizertatie

3	Higher Order Unification and Matching	Higher-order unification is the problem: given an equation t = u containing free variables, is there a solution substitution \sigma˜ such that t\sigma˜ and u\sigma˜ have the same normal form? The terms are drawn from the simply typed lambda calculus. Higher order matching is the particular instance: when the term u is closed, can t be pattern matched to u? Although higher-order unification is undecidable (even if free variables are only second-order), higher-order matching was conjectured to be decidable by Huet. The aim of this thesis is to study the theoretical foundations and to implement higher order unification/matching, and apply the implementation in relevant examples.	Licenta, dizertatie
4	Visualization methods for large libraries of mathematical knowledge	There are several formalize mathematical knowledge bases available (e.g. the Mizar library, HELM). There are many computer-supported systems for doing mathematics. Yet these had little impact the way mathematicians work. This has partly to do with the fact that these systems are hard to use. The aim of this thesis is to investigate techniques to make large knowledge bases of mathematics easier to navigate: define and implement (visual) tools to navigate/explore such knowledge bases.	Licenta, dizertatie
5	Abstract State Machines and Applications (1-2 theses)	The Abstract State Machine (ASM) Project (formerly known as the Evolving Algebras Project) was started by Yuri Gurevich as an attempt to bridge the gap between formal models of computation and practical specification methods. The ASM thesis is that any algorithm can be modeled at its natural abstraction level by an appropriate ASM. Based upon this thesis, members of the ASM community have sought to develop a methodology based upon mathematics which would allow algorithms to be modeled naturally; that is, described at their natural abstraction levels. The purpose of this thesis is to investigate and use in practical examples the concept of ASMs.	Licenta, dizertatie
6	K-framework and its applications (1-2 theses)	K is a rewrite-based executable semantic framework in which programming languages, type systems and formal analysis tools can be defined using configurations, computations and rules. Configurations organize the state in units called cells, which are labeled and can be nested. Computations carry computational meaning as special nested list structures sequentializing computational tasks, such as fragments of program. Computations extend the	Licenta, dizertatie

		original language abstract syntax. K (rewrite) rules make it explicit which parts of the term they read-only, write-only, read-write, or do not care about. This makes K suitable for defining truly concurrent languages even in the presence of sharing. Computations are like any other terms in a rewriting environment: they can be matched, moved from one place to another, modified, or deleted. This makes K suitable for defining control-intensive features such as abrupt termination, exceptions or call/cc. The purpose of this thesis is to investigate and use in practical examples the concepts from K.	
7	Computer Supported Theorem Proving using Isabelle	Isabelle is a generic proof assistant. It allows mathematical formulas to be expressed in a formal language and provides tools for proving those formulas in a logical calculus. The main application is the formalization of mathematical proofs and in particular formal verification, which includes proving the correctness of computer hardware or software and proving properties of computer languages and protocols.	Licenta, master
8	Computer Supported Theorem Proving using Coq	Coq is a formal proof management system. It provides a formal language to write mathematical definitions, executable algorithms and theorems together with an environment for semi-interactive development of machine-checked proofs.	Licenta, master
9	Topics proposed by students	I will also accept to supervise topics proposed by students, provided that I'm in position to do so, i.e. topics covered are logic, logic programming, constraint solving, theorem proving, computer algebra.	Licenta, dizertatie

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Odată cu alegerea unei teme, este necesară înscrierea pe classroom, cod: aq6j64y

Nr. crt.	Denumire temă	Descriere temă	Specializare IACD, AIDC, IS, BigData, BioInf, SC
1	Ingesting VIVO	Dezvoltarea/adaptarea unor mecanisme pentru colectare si import automat a datelor in VIVO, utilizand o abordare bazata pe tehnologii workflow (Camunda, Activiti)	
2	Wokflow engines & patterns	Realizarea unui studiu comparativ al principalelor solutii de tipul workflow engine (ex. Camunda, Activiti, jBPM, etc.) prin prisma “workflow patterns”. https://github.com/meirwah/awesome-workflow-engines	
3	Limbaje pentru micro-servicii	Realizarea unui studiu comparativ al pricipalelor limbaje/biblioteci pentru micro-servicii (ex. Akka, Vert.x, jolie, etc.)	
4	Integration patterns/data integration	Realizarea unui studiu legat de Enterprise Integration Patterns și utilizarea acestora. Studiul va acoperi diferite sisteme care facilitează transportul mesajelor (Enterprise Service Bus), cu o atenție deosebită pentru Apache Camel și concepte legate de ‘data integration’. (Enterprise Integration Patterns 5Designing, Building, and Deploying Messaging Solutions by Gregor Hohpe and Bobby Woolf)	
5	Adaptarea bibliotecilor matematice pentru un mediu distribuit bazat pe Scala	Limbajul Scala oferă suportul ideal pentru construirea de aplicații scalabile. Bibliotecile lapack/blas oferă, pe de altă parte, suportul necesar pentru rezolvarea unor probleme matematice complexe. Prin adaptarea acestor biblioteci la un mediu bazat pe scala se oferă suportul pentru exploatarea intensivă a acestor biblioteci matematice. Lucrarea își propune exploatarea modelului bazat pe actori din scala în scopul expunerii suportului matematic.	

		Suport tehnologic: XML, lapack/blas, platforme bazate pe scala Limbaje: Scala/Akka, Java, C/C++	
6	Teme propuse	Cel mult două teme la propunerea studenților.	

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Nr. crt.	Denumire temă	Descriere temă	Specializare IACD, AIDC, IS, BigData, BioInf, SC
1.	Desktop Collaboration Tool on a Windows platform	Design and implement a tool that provides groups management, resource sharing, messaging, project management.	AIDC, IACD, SC
2.	Desktop Collaboration Tool on a Linux platform	Design and implement a tool that provides groups management, resource sharing, messaging, project management.	AIDC, IACD, SC
3.	Proximity Server design and implementation	A proximity server provides security services, VPN, resource sharing, messaging, etc., at community (~4000 clients) level.	AIDC, IACD, SC
4.	Algorithm for planar graphs representation	Design and implement an algorithm for drawing planar graphs in the plane or on the sphere, based on its GraphML description.	AIDC, IACD

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Nr. crt.	Denumire tema	Descriere temă	Specializare IACD, IS, BIOINFORMATICA, SECURITATE CIBERNETICA, AIDC, BIGDATA
1.	Accessing NoSQL databases using Object Mapping libraries	There are various libraries – multi-database support as Kundera or Spring Data and various native drivers (Cassandra, Mongo), – that can be used to abstract the access to data in NoSQL database, similar to libraries for relational database.	BIGDATA, IS
2.	Sistem pentru recomandarea de jurnale / conferinte	Pe baza unui abstract al unei lucrari (stiintifice), sistemul sa ofere recomandari cu privire la conferinte / jurnale potrivite pentru publicare	ALL
3	Platforme pentru publicarea datelor deschise (Open Data)	Standarde pentru publicarea datelor deschise (DCAT - https://www.w3.org/TR/vocab-dcat-2/) Platforme pentru publicarea si managementul datelor (CKAN.ORG)	ALL
4	Monitorizare si planificare pentru clustere Apache Hadoop	• Apache Hadoop este un framework care permite procesarea distribuita a seturilor de date de mari dimensiuni folosind paradigme Map-Reduce pe clustere de calculatoare • Scop: Monitorizarea si lansarea de job-uri pe clustere Hadoop • Obiective: proiectarea si implementarea componentei de monitorizare; proiectarea si implementarea componentei de lansare • Cerinte: Java • http://hadoop.apache.org	ALL

		• Vezi si: http://pkghosh.wordpress.com/2011/07/30/multi-cluster-hadoop-job-monitoring/	
5	Implementari paralele / distribuite ale algoritmilor Machine Learning in sistemul R	• Procesarea volumelor mari de date cu algoritmi de tip ML (SVM, GLM, Decision Trees etc) este mare consumatoare de timp; implementarile folosind calcul paralel/disitribuit optimizeaza timpul de procesare	BIGDATA
6	Studiu GraphQL	• Motivare • Implementare • Exemple	IS

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Nr	Tema	Detalii	Specializare
1	Review/study of pattern-matching algorithms on heterogeneous CPU/GPU systems	Analiza și implementarea a cel puțin 6 algoritmi diferiți pentru regăsirea de șabloane (texte) pe CPU și GPU (CUDA sau OpenCL). Realizarea unui profil de performanță a algoritmilor testați. Evidențierea domeniilor de interes pentru acest tip de algoritmi. Analiza posibilității implementării algoritmilor în arhitecturi eterogene CPU/GPU. Opțional: propunerea unui algoritm propriu pentru pattern-matching, și compararea acestuia (ca nivel de performanță) cu cele existente. Cunoștințe necesare: structuri de date avansate, algoritmică, calcul paralel.	Securitate cibernetică, Big data, IS
2	Review/study of static and/or dynamic data analysis methods for threat detection/mitigation in intrusion detection systems.	Analiza metodelor recente de analiză statică și/sau dinamică, folosite în mod activ în detecția programelor malițioase (e.g. trojans, viruses, etc.) sau în sistemele de detecție a intrușilor (e.g. firewalls, packet sniffers, etc.). Evidențierea metodelor de detecție și contextul aplicării acestora în sistemele de detecție a intrușilor. Analiza performanțelor metodelor selectate și compararea acestora sub formă de studiu bibliografic. Opțional: Propunerea unei metode proprii de analiză statică și/sau dinamică pentru sistemele de detecție a intrușilor. Cunoștințe necesare: structuri de date avansate, algoritmică, calcul paralel.	Securitate cibernetică, Big data, IS

3	Review/study of static and dynamic data analysis in digital forensics.	Analiza metodelor de analiză statică și/sau dinamică de date pentru investigații digitale. Compararea performanțelor acestora sub formă de studiu bibliografic (cu implementarea cel puțin a unui algoritm din cele studiate). Studiul fezabilității aplicării metodelor în diverse contexte: reconstrucția imaginilor, recuperarea datelor, reconstrucția formatelor video, etc. Opțional: propunerea și implementarea unui algoritm propriu pentru analiză statică și/sau dinamică de date în contextul ales (cu compararea performanțelor sale cu cele existente). Cunoștințe necesare: structuri de date avansate, algoritmică, calcul paralel.	Securitate cibernetică, Big data, IS
4	Review/study of static analysis applied to biometric forensics. Case-study: DNA analysis through pattern-matching techniques.	Analiza metodelor de analiză statică pentru investigații biometrice. Compararea performanțelor acestora în diverse contexte și sub diverse abordări (e.g. folosind expresii regulare simple, complexe sau ambele), sub formă de studiu bibliografic (cu implementarea cel puțin a unui algoritm din cele studiate). Opțional: propunerea, formalizarea și implementarea unui algoritm propriu de analiză statică, cu sau fără suport pentru expresii regulate. Cunoștințe necesare: structuri de date avansate, algoritmică, elemente de bază de bioinformatică.	Securitate cibernetică, Big data, Bioinformatică, IS

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Nr. crt.	Denumire temă	Descriere temă	Specializare **IACD**, **IS**, **BIOINFORMATICA**, **SECURITATE CIBERNETICA**, **AIDC**, **BIGDATA**
1.	Operatii de baza pe matrici rare	In general, o matrice rara este o matrice in care procentul valorilor nenule nu depaseste 5%. Rezolvarea sistemelor de ecuaii a caror matrice asociata este o matrice rara poate fi făcuta mult mai eficient atât în ceea ce privește spatial de stocare, cât și timpul de calcul. Stocarea eficienta in memorie a matricilor rare se face folosind formate specifice (CSR, CSC, Coordinate, Diagonal Storage, Skyline Storage, BSR). Candidatul va trebui sa propuna si sa implementeze metode de operare in astfel de matrici, inclusiv pentru cazul in care matricile operand sunt stocate in formate diferite.	-//- 1 student
2.	Preconditionarea sistemelor de ecuatii cu matrici rare stocate in formate condensate, prin reducerea benzii si a benzii medii.	Preconditionarea sistemelor de ecuatii consta in transformarea matricii asociate astfel incat o anumita metoda de rezolvare sa fie mai eficienta. Candidatul va trebui sa propuna si sa implementeze o metaeuristica pentru reducerea celor doi indicatori prin exploatarea formatelor eficiente de stocare a matricilor rare	2 studenti
3.	Paralelizarea algoritmilor evolutionari	Stiut fiind ca implementarea seriala a algoritmilor evolutivi nu conduce la solutii eficiente din punct de vedere al timpului de executie, candidatul va trebui sa propuna si sa implementeze algoritmi paraleli pentru cativa algoritmi evolutivi.	3 studenti
4	Simulator circuite logice	Implementarea unei aplicatii cu interfata grafica care sa permita simularea functionarii unui circuit logic. Utilzatorul poate construi circuitul prin selectarea si interconectarea grafica a portilor logice de baza. Gasirea unui circuit echivalent mai eficient din punct de vedere al numarului de porti utilizate va fi o alta optiune. Reprezentarea grafica a circuitului pornind de la expresia logica, respectiv gasirea unei expresii	1 student

		logice simplificate precum si reprezentrea grafica a celei din urma ar putea fi alte facilitati ale aplicatiei.	
6	Aplicatii ale recunoașterii starilor emoționale folosind dispozitive mobile	Recunoașterea stărilor emoționale ale utilizatorilor umani a atras multa atenție în ultimii ani, în principal datorită abundenței aplicațiilor capabile să exploateze și să se adapteze la utilizatori.	2 studenti
Alte subiecte pot fi acceptate la propunerea studentului / Other topics may be accepted on a proposal from student			

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Nr. crt.	Denumire temă	Descriere temă	Specializare IACD, IS, BIOINFORMATICA, SECURITATE CIBERNETICA, AIDC, BIGDATA
	Teme la alegere care abordeaza probleme din lumea reala, limbajul natural, rationamentul automat: • Explorarea teoriilor matematice, • Sinteza algoritmilor, • Verificarea corectitudinii algoritmilor, • Analiza complexitatii algoritmilor, • Eficienta, predictii, • Aplicatii pentru muzicieni.	Deprinderi: Mathematica/Theorema/Coq/ SMT & SAT solvers Redactare: LaTeX, limba engleza.	

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Nr	Denumire temă	Descriere temă	Specializare IACD, IS, BIOINFORMATICA, SECURITATE CIBERNETICA, AIDC, BIGDATA
1	Face detection	Detection of faces in images/video using OpenCV or Matlab/ Cuda	
2	Marker detection on human face	Detecting markers on face using OpenCV or Matlab/ CUDA	
3	Blood vessel detection in fundus photographs	Using OpenCV or Matlab/ CUDA	
4	Image Restoration by using different deconvolution algorithms	Using OpenCV or Matlab/ CUDA	
5	Recognition of doors and steps	Using OpenCV or Matlab/ CUDA	
6	Matching Algorithms for Image Recognition	Using OpenCV or Matlab/ CUDA	
7	Image Enhancement Methods	Using OpenCV or Matlab/ CUDA	
8	Deformations and Discriminative Models for Image Recognition	Using OpenCV or Matlab/ CUDA	
9	Medical image processing of X-ray images	Using Cuda or OpenCV or Matlab/ CUDA	
10	An embedded system on car to do self parking	C/C++	
11	Simulation of smoke in WebGL	Using WebGL	

Erașcu Mădălina (madalina.erascu@e-uvt.ro)

Bachelor and Master Theses

Specialization: All Bachelor and Master Specializations

Remarks:

1. All theses must be written in English.
2. Usage of Latex is mandatory.
3. In order to work with me on the following topics, you have to show disponibility in meeting regularly (weekly) and tackling research problems.

Nr	Topic	Observations
1.	Symbolic Automata: Theory and Applications (1 thesis)	Classic automata theory builds on the assumption that the alphabet is finite. For practical applications (e.g. XML processing, program trace analysis) this is inconvenient because they use values for individual symbols that are typically drawn from an infinite domain. Even when the alphabet is finite, classic automata may sometimes be a bad choice: for example, a deterministic finite automaton modelling a language over the UTF16 alphabet requires 2^16 transitions out of each state! *Symbolic Finite Automata (SFA)* are finite state automata in which the alphabet is given by a Boolean algebra that may have an infinite domain, and transitions are labeled with first-order predicates over such algebra. *SFA* are more expressive than deterministic finite automata, however, are closed under Boolean operations and admit decidable equivalence. Moreover, for large alphabets SFA outperforms their classic counterpart. The aim of these theses is to: Present theory of SFA: definitions, examples, comparisons to classical finite automata Implement certain algorithms related to *Decision Problems and Closure Properties*, *Learning*, *Applications*.

		Difficulty: medium **Requirements**: *Theory*: Formal Languages and Automata Theory (notions from 1st year lecture); *Programming*: Python; **Resources**: http://pages.cs.wisc.edu/~loris/symbolicautomata.html
2.	Benchmark problems for the constraints satisfaction problems (CSP) repository (1 thesis)	The project involves preparing and submitting existing constraints satisfaction problems to the constraints satisfaction problems repository. **Difficulty**: medium **Requirements**: *Programming*: Python; *Math*: computational logic, in particular the notions taught in the lecture Logic for Computer Science and/or Formal Methods in Software Development. **Resources**: http://www.csplib.org
3.	Predicting the fastest method for constrained satisfaction/ optimization problems (2 theses; preferably students who worked together during university projects)	Constrained optimization/satisfaction problems can be encoded in different logical theories (propositional logic, integers, reals, or combinations). The encoding influences the running time of the algorithms/tools solving the problem. We propose two theses: ● One investigates the best algorithm/tool, from the computational time point of view, for solving the problem. ● The other studies, implements, and performs experiments with incremental techniques for SAT/SMT solving for speeding up the existing algorithms/tools. **Difficulty**: high **Requirements**: *Programming*: Python; *Math*: computational logic, in particular the notions taught in the lecture Logic for Computer Science and/or Formal Methods in Software Development. **Resources**: (1) Influence of Variables Encoding and Symmetry Breaking on the Performance of Optimization Modulo Theories Tools Applied to Cloud Resource Selection - Madalina Erascu, Flavia Micota, Daniela Zaharie (2) An Algorithm Selection Approach for QF FP Solvers, Joseph Scott, Pascal Poupart, and Vijay Ganesh

4.	Binarized Neural Networks. Training and Verification (2 theses; preferably students who worked together during university projects)	Deep learning is everywhere. It has been shown its practical application in a variety of fields, image recognition, natural language processing, recommendation systems, autonomous driving, just to name a few. Deep learning algorithms are mainly used as a black-box and hence difficult to debug. In fact, the main criticisms to deep learning algorithms are *uncertainty* and unexpected behavior on *adversarial examples*. When we talk about safety-critical systems, it is important that correctness guarantees exist. This leads to the application of *formal verification* to deep neural networks (DNNs), that is, given a DNN and a specification, is there a proof that the DNN satisfies the specification for all inputs? Not surprisingly, the main challenge of applying formal methods to the verification of DNNs is *scalability*. This is because verification is a non-trivial problem: DNNs are large (high number of neurons and layers) and involve activation functions which are non-linear and non-convex. These make the problem NP-complete. We offer three theses for studying three different verification approaches. The theses should contain a comprehensive state-of-the-art as well demo with at least one of the tools from the state-of-the-art. The demo will ensure reproducibility of the results obtained by state-of-the-art. **Difficulty**: high **Requirements**: *Programming*: Python; *Math*: Logic, linear algebra and statistics **Resources**: (1) Verifying Properties of Binarized Deep Neural Networks – N. Narodytska et all, AAAI-18 (2) Formal Analysis of Deep Binarized Neural Networks – N. Narodytska, IJCAI-18
5.	Invariant generation (1 thesis)	Program analysis requires the generation of program properties expressing conditions to hold at intermediate program locations. When it comes to programs with loops, these properties are typically expressed as loop invariants. The aim of this thesis is to study/compare/test methods for invariant generation available in the literature.. **Difficulty**: high

		Requirements: *Programming*: Python; *Computer Science*: Algorithms and Data Structures **Resources**: (1) Dafny (https://github.com/dafny-lang/dafny). (2) *Assigning meaning to programs* by Robert Floyd.
6.	Synthesis of optimal numerical algorithms (1 thesis)	Program synthesis is the automatic construction of software that provably satisfies a given specification (input and output condition). Given a specification of what a program should do, the synthesizer generates an implementation that satisfies this specification. The aim of the thesis is to study the possibility of the synthesis of algorithms (e.g. reciprocal, square root, reciprocal square root of numbers) suitable for hardware implementations. The main characteristic of these algorithms is that they do not contain the division operation, which is expensive. The experiments will be conducted in Mathematica. **Difficulty**: high **Requirements**: *Programming*: Mathematica; *Math*: computational logic **Resources**: (1) Madalina Erascu, Hoon Hong: Real quantifier elimination for the synthesis of optimal numerical algorithms (Case study: Square root computation). J. Symb. Comput. 75: 110-126 (2016)
7.	Comparative study of formal analysis methods for biological networks involved in the development of resistance of microorganisms to antibiotics. (1 thesis).	Formal analysis of biological networks has the potential of developing reliable and efficient methods and tools for patterns (motifs) identification which could help in *understanding the mechanisms behind complex phenomena* (e.g. antimicrobial resistance). **Difficulty**: high **Requirements**: *Programming*: Python; *Math*: basic abstract algebra, computational logic, in particular the notions taught in the lecture Formal Methods in Software Development. *Interest* in bioinformatics.

		Resources: (1) Formal Analysis of Network Motifs, Hillel Kugler, Sara-Jane Dunn, Boyan Yordano, https://www.biorxiv.org/content/10.1101/347500v1.full.pdf
8.	Investigation of symmetry breaking methods for formal analysis methods for biological networks involved in the development of resistance of microorganisms to antibiotics. (1 thesis).	Formal analysis of biological networks has the potential of developing reliable and efficient methods and tools for patterns (motifs) identification which could help in *understanding the mechanisms behind complex phenomena* (e.g. antimicrobial resistance). As it is an intractable task, we aim to study the usability of symmetry breaking methods for speeding it up. **Difficulty**: high **Requirements**: *Programming*: Python; *Math*: basic abstract algebra, computational logic, in particular the notions taught in the lecture Formal Methods in Software Development. *Interest* in bioinformatics. **Resources**: (1) Formal Analysis of Network Motifs, Hillel Kugler, Sara-Jane Dunn, Boyan Yordano, https://www.biorxiv.org/content/10.1101/347500v1.full.pdf
9.	I also supervise projects proposed by students. These should be related to my interests: ● Formal Methods, in particular Static Software Verification; ● Automated Theorem Proving, in particular First-Order Theorem Proving; ● Software Engineering ● Symbolic Computation, in particular Polynomial Algebra; ● Distributed Computing, in particular Cloud and Big Data Computing.	