

Študijný program / *Study programme:* Informatika / *Computer Science*

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Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Abduktívne usudzovanie nad ontológiami s využitím kalkulu so spätným reťazením
Abductive reasoning with ontologies based on a reverse consequence calculus

Jazyk záverečnej práce / *Language of Thesis*

anglický / *English*

Školiteľ / *Tutor*

doc. RNDr. Martin Homola, PhD.

Anotácia / *Annotation*

Abduktívne usudzovanie je v oblasti ontológie (a špecificky deskriptívnych logík) stále novou a neštandardnou inferenčnou úlohou. V súčasnosti sú známe viaceré návrhy a implementácie abduktívnych inferenčných strojov; sú však založené na prehľadávaní obrovského priestoru hypotetických vysvetlení s opakovaným volaním externého DL odvodzovača. Efektívnejšie prístupy k abdukcii s využitím spätného reťazenia sú známe v oblasti logického programovania. Len v nedávnej dobe sa objavili odvodzovacie algoritmy pre deskriptívne logiky založené na kalkuloch s dopredným reťazením. Tieto techniky umožňujú preskúmať abduktívne metódy založené na spätnom vyhodnocovaní takýchto kalkulov.

Abductive reasoning is still a novel and non-standard reasoning task in the area of ontologies, and specifically description logics. Several work have yielded abductive reasoners, however such approaches often have to search through a vast space of possible explanations, repeatedly calling an external DL reasoner. More efficient methods which employ backward reasoning are known in the area of Logic Programming. Recently a novel class of DL reasoning algorithms based on consequence calculus appeared, which enables to explore also more direct backward abduction techniques.

Cieľ / *Aim*

- Sémantická charakterizácia abduktívnej inferencie v DL založená na spätnom reťazení • Návrh a implementácia abduktívneho inferenčného algoritmu postaveného na dosiahnutých teoretických výsledkoch • Teoretická a empirická evalvácia
- *Semantic characterization of abductive inference in DL based on backward application of consequence calculus • Development and implementation of an abductive reasoning algorithm based on the obtained theoretical results • Theoretical and empirical evaluation*

Literatúra / *Literature*

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[1] Elsenbroich, C., Kutz, O. and Sattler, U. A case for abductive reasoning over ontologies. In: OWLED 2006 [2] Pukancová, J. and Homola, M. Tableau-Based ABox Abduction for the ALCHO Description Logic. In: DL 2017 [3] Du, J., Qi, G., Shen, Y.D. and Pan, J.Z., 2012. Towards practical ABox abduction in large description logic ontologies. International Journal on Semantic Web and Information Systems (IJSWIS), 8(2):1-33 [4] Simancik, F., Kazakov, Y. and Horrocks, I. Consequence-based reasoning beyond Horn ontologies. In: IJCAI 2011

Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Aktivizácia a použiteľnosť pre virtuálne múzeum
Virtual Museum Activisation and Usability

Jazyk záverečnej práce / *Language of Thesis*

anglický / *English*

Školiteľ / *Tutor*

doc. RNDr. Andrej Ferko, PhD.

Anotácia / *Annotation*

Projekt skúma meranie kvality vytvárania a kódovania multimediálnych objektov vo vzdelávacích hrách s digitálnym kultúrnym dedičstvom.

The project explores the measurement of quality of the development and coding of media objects in educational games with the digital cultural heritage.

Cieľ / *Aim*

Navrhne procedurálnu definíciu virtuálneho múzea a na nej postavenú alternatívnu metodológiu s aktivizáciou pomocou vzdelávacích hier (Serious Games). Preskúmame možnosti na rozšírenie funkčnosti kódovania Europeana Data Model a prezentačného nástroja MOVIO o podporu vzdelávacích hier (Serious Games) na aktivizáciu virtuálnych návštevníkov. Konkrétne budeme skúmať alternatívy merania virtuálneho času pre hry na najlepšie pohľady, interakciu a virtuálne davy.

We will propose a procedural definition of the virtual museum. We plan to built on it an alternative methodology of activization using educational games (Serious Games). We will explore extending the functionality of the Europeana Data Model and of the presentation tool MOVIO. In particular, how to encode or support them with educational games (Serious Games) for the activation of virtual visitors. Specifically, we will examine alternatives of measuring virtual time for games using the best views, user interaction, and virtual crowds.

Literatúra / *Literature*

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Poznámka / *Comment*

Klíčové slová / *Keywords*

Virtual Museum, Activisation, Usability Testing, Serious Games

Virtual Museum, Activisation, Usability Testing, Serious Games

Študijný program / Study programme:

Informatika / Computer Science

Názov / Title

Algoritmy na kubických grafoch

Algorithms on cubic graphs

Jazyk záverečnej práce / Language of Thesis

anglický / English

Školiteľ / Tutor

doc. RNDr. Robert Lukot'ka, PhD.

Anotácia / Annotation

Mnohé významné problémy v teórii grafov sa dajú zredukovať na kubické grafy. Štúdium kubických grafov je preto dôležitou súčasťou teórie grafov. Napriek obmedzeniu kladenému na stupne v kubickom grafe mnohé dôležité problémy, ktoré sú NP-ťažké pre všeobecné grafy zostávajú NP-ťažké aj pre kubické grafy. Cieľom práce je skúmať algoritmy (exaktné, aproximatívne, parametrizované) na ťažké problémy na kubických grafoch jednak z hľadiska ich teoretickej výpočtovej zložitosti ako aj z hľadiska praktickej použiteľnosti na inštanciách dôležitých vo výskume.

Many important problems in graph theory can be reduced to cubic graphs. Therefore, the study of cubic graphs is an important part of graph theory. Despite the restriction on the degrees, many important problems that are NP-hard for general graphs are still NP-hard for cubic graphs. The aim of the thesis is to investigate algorithms (exact, approximation, parametrized) for hard problems on cubic graphs with regards to their theoretical computational complexity and to their usability in practical instances arising in the research.

Študijný program / Study programme:Informatika / Computer Science

Názov / Title

Algoritmy pre vnoriteľnosť grafov do plôch

*Algorithms for graph embeddability into surfaces***Jazyk záverečnej práce / Language of Thesis**

anglický / English

Školiteľ / Tutor

prof. RNDr. Martin Škoviera, PhD.

Anotácia / Annotation

Východiskom práce je fakt, že existuje polynomiálny algoritmus na určenie maximálneho rodu grafu. Dôkaz je existenčný a žiaden taký algoritmus zatiaľ nebol implementovaný. Plánujeme skúmať podobné problémy v širšom kontexte signovaných grafov a lokálne maximálnych vnorení. Jedným z cieľov by malo byť navrhnutie a implementovanie polynomiálneho algoritmu pre niektorý z problémov vnoriteľnosti. Predpokladané metódy sú skôr kombinatorické než topologické.

The point of departure is the fact that there exist a polynomial time algorithm for determining the maximum genus of a graph. The proof is existential and no such algorithm has ever been implemented. We intend to study similar problems in a more general setting of signed graphs and locally maximal embeddings. One of the aims should be designing and implementing a polynomial-time algorithm for one of these embeddability problems. Expected methods are combinatorial rather than topological.

Cieľ / Aim*Cutting-edge research in the area specified in the title*

Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Atraktorová dynamika v biologicky inšpirovaných umelých neurónových sieťach
Attractor dynamics in biologically inspired artificial neural networks

Jazyk záverečnej práce / *Language of Thesis*

anglický / *English*

Školiteľ / *Tutor*

doc. RNDr. Martin Takáč, PhD.

Anotácia / *Annotation*

Interaktívne šírenie aktivácie je už dlho známe ako silný a biologicky plauzibilný mechanizmus. Obvykle je realizované pomocou spätnoväzbových slučiek v konektivite neurónovej siete, napr. pomocou spojení zhora nadol a zdola nahor (McClelland, 1981), rekurentných alebo laterálnych spojení (Sirosh & Miikkulainen, 1994) či cez inhibičné interneuróny (O'Reilly & Munakata, 2000). Tie spôsobia vzájomné súťaženie medzi neurónmi a vytvoria zaujímavú časovú dynamiku s atraktormi zodpovedajúcimi rôznym pamäťovým stavom. (Hopfield, 1982), zároveň prirodzeným spôsobom modelujú reakčný čas. Takáto dynamika tvorí základ mnohých biologicky relevantných modelov, napr. Convergence-divergence architecture (Meyer & Damasio, 2009), Global neuronal workspace (Dehaene et al, 2001), alebo mapy vo vizuálnej kôre (Miikkulainen, 2005). Väčšina implementácií je však veľmi časovo náročná a neefektívna. Cieľom tejto práce bude spracovať a analyzovať existujúce výpočtové architektúry s atraktorovou dynamikou, navrhnúť výpočtovo efektívnu verziu samoorganizujúc sa máp (SOM) s atraktorovou dynamikou s dôrazom na aplikácie v modelovaní kognitívnych procesov.

Interactive activation spreading has long been known as a powerful and biologically plausible mechanism. It is usually realised by feedback loops in the neural network's connectivity, e.g. top-down - bottom-up (McClelland, 1981), recurrent or lateral connections (Sirosh & Miikkulainen, 1994) or via inhibitory interneurons (O'Reilly & Munakata, 2000). It introduces mutual competition among neurons, an interesting temporal dynamic and existence of attractors corresponding to memory states (Hopfield, 1982), hence it can model reaction times in a very natural way. It lies in the core of many biologically relevant models, such as Convergence-divergence architecture (Meyer & Damasio, 2009), Global neuronal workspace (Dehaene et al, 2001), or maps in the visual cortex (Miikkulainen, 2005). However, most of the implementations are notoriously slow and ineffective. The goal of this thesis will be to review and explore computational architectures with attractor dynamics, analyze them and design a computationally effective version, probably focusing on some attractor version of self-organizing maps, with the emphasis in applications in modeling of cognitive processes.

Literatúra / *Literature*

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Kľúčové slová / Keywords

umelé neurónové siete interaktívna aktivácia, laterálne spojenia, atraktorová dynamika
artificial neural networks, interactive activation, lateral connections, attractor dynamics

Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Automatické 3D odhadovanie ľudskej pózy, sledovanie kostry a meranie tela
Automatic 3D Human Pose Estimation, Skeleton Tracking and Body Measurements

Jazyk záverečnej práce / *Language of Thesis*

anglický / *English*

Školiteľ / *Tutor*

doc. RNDr. Milan Ftáčnik, CSc.

Konzultant / *Consultant*

RNDr. Martin Madaras, PhD.

Anotácia / *Annotation*

Odhad pózy ľudského tela a jeho merania sú nové problémy, ktoré priťahujú pozornosť viacerých vedných oblastí. Automatický a presný spôsob analýzy ľudského tela, jeho pózy či pohybu je kľúčový vo viacerých oblastiach priemyslu orientovaného na počítačové videnie. Ľudské telo je zložitá štruktúra, ktorá sa ťažko analyzuje algoritmickými prístupmi. Je ťažké definovať konkrétne body na povrchu tela, ktoré treba analyzovať na získanie presných meraní. Preto v oblasti ťažko definovateľných meraní a odhadov tela prevažujú metódy strojového učenia. Na trénovanie neurónovej siete ako jadra prístupu hlbokého učenia je potrebná veľká množina skenov ľudského tela so známym ohodnotením merania. Takéto dáta sa získavajú virtuálnym skenovaním a používajú sa ako trénovacie dáta pre neurónovú sieť.

The estimation of human body pose and its measurements is an emerging problem that drives attention in many research areas. An automatic and precise way of analyzing the human body, pose or motion is crucial in many fields of the computer vision oriented industry. The human body is a complex structure that is hard to analyze using algorithmic approaches. It is hard to define exact points on the surface to be evaluated in order to retrieve precise measurements. Therefore, machine learning methods tend to drive the area of hard-to-define body measurements and estimations. In order to train a neural network as a core of a deep learning-based approach, a huge set of human body scans with known ground truth estimations is essential. The data need to be generated by virtual scanning and used as the training data for the neural model.

Cieľ / *Aim*

Hlavným zameraním tejto dizertácie je výskum prístupov strojového učenia pre odhadovanie pózy, sledovanie kostry a merania ľudského tela. Pretože nie je verejne dostupný dostatočný počet dát so známymi odhadmi meraní, je nutné podporiť trénovanie neurónových sietí virtuálnymi skenmi. Preto prvým cieľom je integrovať systém virtuálneho skenovania dynamiky tela do postupnosti hlbokého učenia. Potom navrhnúť nový prístup strojového učenia k odhadu pózy a sledovaniu kostry na základe mračna bodov ako vstupu neurónovej siete. Ďalším cieľom je preskúmať využitie mračien bodov ako vstupov aj pri antropometrických meraniach tela a preskúmať rozšírenie vstupných dát z 2D na 3D tak, aby navrhovaná metóda bola robustnejšia a presnejšia. Nakoniec vyhodnotiť vplyv syntetických trénovacích dát uplatnením navrhovaných modelov strojového učenia na reálne ľudské dáta a porovnať výsledky s najlepšimi súčasnými metódami hlbokého učenia, ktoré boli trénované na iných databázach, alebo s inými dostupnými analytickými metódami.

The main focus of the thesis is the research in machine learning-based approaches for pose estimation, skeleton tracking and body measurements. Since there is not enough data with associated ground truth estimations publicly available, the training of the neural networks should

be supported by virtual scans. Thus, the first goal is to integrate the virtual scanning system of a dynamic body into the deep learning pipeline. Then to propose a new machine learning approach for pose estimation and skeleton tracking by incorporating point cloud data as input to the neural model. The next goal is to investigate the use of point clouds as inputs also for anthropometric body measurements and explore the extension of the input data from 2D to 3D in order to make the approach to be more robust and precise. Finally to evaluate the impact of the synthetic training data by applying the proposed machine learning models on real human data and compare the results to state-of-the-art deep learning methods trained using different datasets, or other available analytical methods.

Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Automatizovaná kvalitatívna analýza slovenských textov
Automated qualitative analysis of texts in Slovak

Jazyk záverečnej práce / *Language of Thesis*

slovenský / *Slovak*

Školiteľ / *Tutor*

doc. RNDr. Martin Takáč, PhD.

Anotácia / *Annotation*

V sociálnych vedách rastie množstvo digitalizovaných textov, ktoré treba analyzovať z hľadiska obsiahnutých tém, latentných významov, sentimentov a sémantických kategórií. Algoritmy strojového učenia by mohli pomôcť proces analýzy automatizovať. Sú tu však prekážky: 1) chýbajúce nástroje pre texty v slovenčine. 2) mnohé state-of-the-art nástroje potrebujú príliš veľké množstvo anotovaných tréningových dát 3) slabá transparentnosť algoritmov - chýba vysvetlenie ako dospeli k výsledku. Dizertačná práca sa zameria na výskum vhodných algoritmov strojového učenia použiteľných na kvalitatívnu analýzu slovenských textov s dôrazom na učenie z menšieho množstva dát a na transparentnosť - analýzu a vizualizáciu vytvorených sémantických reprezentácií.

A growing number of digitized texts in social sciences that need to be analysed qualitatively - by topics, latent meanings, sentiments and semantic categories - call for automation. Machine learning algorithms can provide help, but there are the following obstacles: 1) lack of tools for texts in Slovak language 2) many state-of-the-art tools require too many annotated training data 3) lack of transparency - missing explanations. This doctoral research will focus on survey and design or adaptation of suitable machine learning algorithms usable for qualitative analysis of Slovak text with an emphasis on learning from scarce data and on transparency - visualisation and analysis of emerged semantic representations.

Literatúra / *Literature*

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Nan-Chen, Ch et. al. (2018): Using Machine Learning to Support Qualitative Coding in Social Science: Shifting The Focus to Ambiguity. ACM Transactions on Interactive Intelligent Systems 9(4), 39. Humphreys, A. and Wang, R.J.-H. (2018): Automated Text Analysis for Consumer Research. *Journal of Consumer Research* 44(6):1274-1306 Honkela, T. et al. (2010): GICA: Grounded Intersubjective Concept Analysis. Technical report TKK-ICS-R41. Aalto University.

Kľúčové slová / *Keywords*

kvalitatívna analýza, strojové učenie, dolovanie v texte
qualitative analysis, machine learning, text mining

Študijný program / Study programme:

Informatika / Computer Science

Názov / Title

Bezpečnosť - formálny prístup

Security - formal approach

Jazyk záverečnej práce / Language of Thesis

slovenský / Slovak

Školiteľ / Tutor

doc. RNDr. Damas Gruska, PhD.

Anotácia / Annotation

Cieľom práce je výskum prípadne vývoj v oblasti bezpečnosti aplikáciou formálnych metód verifikácie a špecifikácie. Bezpečnosť definujeme pomocou vlastností ako opacity, non-interference a pod., či už ako kvalitatívne alebo kvantitatívne vlastnosti, ktoré chceme analyzovať pomocou formálnych metód a a odpovedajúcich softvérových nástrojov.

The aim of the thesis is research, perhaps also development, in the field of security by application of formal methods for verification and specification. Security will be defined by terms as opacity, non-deducibility, etc, either as qualitative or quantitative properties, which will be analyzed by means of formal methods and corresponding software tools.

Študijný program / Study programme:

Informatika / Computer Science

Názov / Title

Biologicky inšpirované učenie v sekvenčných úlohách
Biologically inspired learning of sequential tasks

Jazyk záverečnej práce / Language of Thesis

anglický / English

Školiteľ / Tutor

prof. Ing. Igor Farkaš, Dr.

Anotácia / Annotation

Research suggests that machine learning can benefit from biological principles of learning (e.g. in the brain). Inspiration from nature can help avoid mechanisms that lack biological support, provide better solutions and faster learning. Very important is the domain of sequential learning which spans a wide variety of tasks needed for an intelligent artificial agent, such as sensorimotor learning, sequence prediction, temporal recognition, store-recall, planning behavior, and others, where various learning paradigms can be useful (supervised, unsupervised, reinforcement).

Cieľ / Aim

1. Modify and implement the new method e-prop (Bellec et al., 2019) for an artificial neural network and test it on selected tasks, with focus on robotics. 2. Provide computational analysis of the trained model and compare it with other methods on selected tasks.

Literatúra / Literature

*G. Bellec, F. Scherr, E. Hajek, D. Salaj, R. Legenstein, and W. Maass. Biologically inspired alternatives to backpropagation through time for learning in recurrent neural nets. arxiv.org/abs/1901.09049, 2019. M. Butz et al.: Learning, planning, and control in a monolithic neural event inference architecture. *Neural Networks*, 2019. R. Sutton, A. Barto: *Reinforcement Learning: An Introduction* (2nd ed.). The MIT Press, 2018.*

Študijný program / Study programme:

Informatika / *Computer Science*

Názov / Title

Biologicky motivované výpočtové modely

Biologically motivated computational models

Jazyk záverečnej práce / Language of Thesis

slovenský / *Slovak*

Školiteľ / Tutor

doc. RNDr. Damas Gruska, PhD.

Anotácia / Annotation

Ciele široko zameranej témy sú: výskum v oblasti biologicky motivovaných výpočtových modelov, skúmanie ich vlastností, vzájomného vzťahu, návrh vlastných modelov, porovnanie s existujúcimi, nástroje na verifikáciu, model checking a pod.

The aim of the thesis is research in the field of biologically motivated computational models, a study of their properties, relationships, a proposal of new models and their comparison with existing ones, tools for their verifications, model checking etc,

Študijný program / Study programme:

Informatika / Computer Science

Názov / Title

Cykly a 1-faktory v kubických grafoch

Cycles and perfect matchings in cubic graphs

Jazyk záverečnej práce / Language of Thesis

anglický / English

Školiteľ / Tutor

doc. RNDr. Edita Mačajová, PhD.

Anotácia / Annotation

Cyklus je graf, ktorého každý vrchol má párny stupeň a 1-faktor množina hrán, ktorá pokrýva každý vrchol práve raz. Keďže komplement ku každému 1-faktoru v kubickom grafe je cyklus, tieto dva pojmy sú navzájom úzko späté a tvoria základné štruktúry pre viaceré dlhodobé otvorené problémy z teórie grafov. Cieľom dizertačnej práce bude dosiahnuť nové výsledky v oblasti cyklov a 1-faktorov, konkrétnejšie napr. v oblasti Orientovanej hypotézy o dvojitom pokrytí cyklami, rozšíriteľnosti množiny hrán na 1-faktor a krátkom pokrytí cyklami.

A cycle is a graph with all vertices of even degree. A perfect matching of a graph is set of edges that covers every vertex exactly once. As the complement to a perfect matching is a cycle, these two notions are closely connected and form basic structures for several longstanding problems in graph theory. The goal of the PhD. thesis will be to obtain new results in the area of cycles and perfect matchings, more precisely, for example, in the area of Oriented cycle double cover conjecture, extendability of a set of edges to a perfect matching in a cubic graph, and short cycle covers.

Študijný program / Study programme:

Informatika / Computer Science

Názov / Title

Formálne metódy pre verifikáciu a špecifikáciu konkurentných a paralelných systémov
Formal methods for verifications and specifications of concurrent and parallel systems

Jazyk záverečnej práce / Language of Thesis

slovenský / Slovak

Školiteľ / Tutor

doc. RNDr. Damas Gruska, PhD.

Anotácia / Annotation

Ciele široko zameranej témy sú: výskum v oblasti formálnych metód pre špecifikáciu a verifikáciu konkurentných a paralelných systémov, softvérových alebo hardvérových, návrh vlastných modelov, porovnanie s existujúcimi, nástroje na verifikáciu, model checking a pod.

The aim of the thesis is research in formal methods, which includes: verification and specification of concurrent and parallel software or hardware systems, models of computation, their comparison with existing models, tools for verification, model checking etc.

Študijný program / Study programme:

Informatika / Computer Science

Názov / Title

Fundamentálne vlastnosti informácie a zložitosť problémov

Fundamental properties of information and complexity of problems

Jazyk záverečnej práce / Language of Thesis

anglický / English

Školiteľ / Tutor

prof. RNDr. Branislav Rován, PhD.

Anotácia / Annotation

Dosiahnuť nové výsledky v oblasti skúmania základných vlastností pojmu informácia a vplyvu dodatočnej informácie na zložitosť riešenia problémov. Výskum bude nadväzovať na doterajšie dosiahnuté výsledky na pracovisku (týkajúce sa napríklad užitočnosti informácie, aktuálnosti informácie a pod.).

To achieve new results in the research of fundamental properties of the notion of information and the influence of additional information on the complexity of problem solving. The research shall build upon the research achieved at the department (concerning, e.g., the usefulness of information, timeliness of information, etc.)

Cieľ / Aim

Dosiahnuť nové výsledky v oblasti skúmania základných vlastností pojmu informácia a vplyvu dodatočnej informácie na zložitosť riešenia problémov. Výskum bude nadväzovať na doterajšie dosiahnuté výsledky na pracovisku (týkajúce sa napríklad užitočnosti informácie, aktuálnosti informácie a pod.).

To achieve new results in the research of fundamental properties of the notion of information and the influence of additional information on the complexity of problem solving. The research shall build upon the research achieved at the department (concerning, e.g., the usefulness of information, timeliness of information, etc.)

Študijný program / Study programme:

Informatika / *Computer Science*

Názov / Title

Komunikácia vo (formálnych) výpočtových modeloch

Communication in (formal) computational models

Jazyk záverečnej práce / Language of Thesis

anglický / *English*

Školiteľ / Tutor

doc. RNDr. Dana Pardubská, CSc.

Anotácia / Annotation

štúdium vplyvu spôsobu a množstva komunikácie na výpočtovú silu/zložitosť výpočtových modelov/problémov

Study of influence of type and amount of communication on computational power / complexity of computational models / problems

Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Kryptoanalýza symetrických šifier

Cryptanalysis of symmetric ciphers

Jazyk záverečnej práce / *Language of Thesis*

slovenský / *Slovak*

Školiteľ / *Tutor*

doc. RNDr. Martin Stanek, PhD.

Anotácia / *Annotation*

Výber vhodnej triedy symetrických šifier a preskúmanie súčasného stavu konštrukcie a analýzy používaných algoritmov. Zlepšenie metód kryptoanalýzy, prípadne návrh vlastných metód.

Teoretická analýza zložitosti a predpokladov navrhnutých postupov, spolu s ich experimentálnym overením.

Študijný program / Study programme:

Informatika / Computer Science

Názov / Title

Metódy spracovania dát zo sekvenačných technológií tretej generácie

Methods for processing data from third generation sequencing technologies

Jazyk záverečnej práce / Language of Thesis

slovenský / Slovak

Školiteľ / Tutor

doc. Mgr. Tomáš Vinař, PhD.

Anotácia / Annotation

Najnovšie sekvenačné technológie produkujú sekvencie, ktoré sú síce veľmi dlhé, na druhej strane ich chybovosť sa pohybuje až do 30%. Využitie takýchto dát si vyžaduje formuláciu a výskum nových algoritmických problémov. Cieľom práce je formulovať nové problémy súvisiace s takýmito sekvenovacími technológiami a hľadať riešenia prostredníctvom techník strojového učenia, tvorby efektívnych algoritmov a pravdepodobnostného modelovania.

The newest sequencing technologies produce long sequences with large error rates of up to 30%. Using such data requires formulation and research of new algorithmic problems. The goal of the thesis is to formulate new problems related to the third generation sequencing technologies and provide solutions using machine learning, algorithmic, and probabilistic modeling techniques.

Študijný program / Study programme:Informatika / *Computer Science*

Názov / Title

Metódy strojového učenia na predikciu regulácie génov špecifických pre tkanivá
Machine learning approaches to prediction of tissue-specific gene regulatio

Jazyk záverečnej práce / Language of Thesisanglický / *English***Školiteľ / Tutor**

doc. Mgr. Tomáš Vinař, PhD.

Konzultant / Consultant

Dipl. Ing. Igor Jurisica, PhD.

Anotácia / Annotation

Expresia ľudských génov je regulovaná mnohými mechanizmami a táto regulácia je vysoko tkanivovo špecifická. Moderné technológie priniesli obrovské množstvo experimentálnych dát, ktoré poukazujú na rôzne aspekty takejto regulácie. Cieľom je vyvinúť efektívne a presné metódy založené na strojovom učení alebo štatistických prístupoch na predpovedanie tkanivovo špecifických regulačných vzťahov medzi špecifickými regulátormi, ako sú transkripčné faktory a mikroRNA, a nimi regulovanými génmi. Práca bude prebiehať v spolupráci s prof. Igorom Jurišicom z Univerzity v Toronte a bude budovať na databázach mirDIP a Catrin vytvorených v jeho skupine. Študent bude tiež lokálne spolupracovať s Neuroimunologickým ústavom Slovenskej akadémie vied.

Expression of human genes is regulated by many mechanisms, and this regulation is highly tissue-specific. Modern technologies have produced vast quantities of experimental data assessing various aspects of this regulation. The goal is to develop efficient and accurate machine learning or statistical approaches to predict tissue-specific regulatory relationships between specific regulators, such as transcription factors and microRNAs and the genes they regulate. The thesis will be co-supervised by prof. Igor Jurisica from the University of Toronto and will build on the mirDIP and Catrin databases created in his group. The student will also collaborate locally with the Institute of Neuroimmunology at the Slovak Academy of Sciences.

Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Metódy umelej inteligencie v počítačových hrách

AI methods in computer games

Jazyk záverečnej práce / *Language of Thesis*

anglický / *English*

Školiteľ / *Tutor*

doc. RNDr. Martin Homola, PhD.

Anotácia / *Annotation*

Skoro všetky počítačové hry vykazujú nejakú formu "inteligentného správania". Aj dnes je však úplne bežné, že tieto správania sú implementované hardkódovanými algoritmami bez využitia metód UI. Širšia aplikácia metód UI tak pre oblasť počítačových hier predstavuje zaujímavú výzvu, ktorá môže priniesť posun k skutočne inteligentným hrám.

Almost any computer game exhibit "intelligent behaviours" however until this day these are often implemented by hardcoded algorithms without application of mainstream AI methods. Application of these methods thus presents an interesting challenge which may help to push towards really intelligent computer games.

Cieľ / *Aim*

Aplikácia metód umelej inteligencie na rôzne problémy v počítačových hrách.

Application AI methods on various problems in computer games.

Literatúra / *Literature*

[1] Garcez, A.D.A., Gori, M., Lamb, L.C., Serafini, L., Spranger, M. and Tran, S.N., 2019. Neural-Symbolic Computing: An Effective Methodology for Principled Integration of Machine Learning and Reasoning. arXiv preprint arXiv:1905.06088. [2] Besold, T.R., Garcez, A.D.A., Bader, S., Bowman, H., Domingos, P., Hitzler, P., Kühnberger, K.U., Lamb, L.C., Lowd, D., Lima, P.M.V. and de Penning, L., 2017. Neural-symbolic learning and reasoning: A survey and interpretation. arXiv preprint arXiv:1711.03902. [3] Hitzler, P., Bianchi, F., Ebrahimi, M. and Sarker, M.K., 2019. Neural-symbolic integration and the Semantic Web. *Semantic Web*

[1] Laird, J. and VanLent, M., 2001. Human-level AI's killer application: Interactive computer games. *AI magazine*, 22(2), pp.15-15. [2] Nareyek, A., 2004. AI in computer games. *Queue*, 1(10), p.58. [3] Magerko, B., Laird, J.E., Assanie, M., Kerfoot, A. and Stokes, D., 2004, July. AI characters and directors for interactive computer games. In *AAAI* (pp. 877-883).

Študijný program / Study programme:Informatika / Computer Science

Názov / TitleMiere nezafarbiteľnosti kubických grafov
*Measures of uncolourability of cubic graphs***Jazyk záverečnej práce / Language of Thesis**

anglický / English

Školiteľ / Tutor

prof. RNDr. Martin Škoviera, PhD.

Anotácia / Annotation

Každý kubický graf sa dá hranovo zafarbiť tromi alebo štyrmi farbami tak, aby susedné hrany mali vždy rôznu farbu. Tie, ktoré potrebujú štyri farby, sa nazývajú nezafarbiteľné. Nezafarbiteľné kubické grafy (nazývané tiež snarky) hrajú kľúčovú úlohu ako potenciálne protipríklady k viacerým dôležitým a dlhodobo otvoreným hypotézam v diskkrétnej matematike. Existujú rozličné miery nezafarbiteľnosti kubických grafov, napr. nepárnosť, rezistencia, počet 1-faktorov potrebných na pokrytie všetkých hrán a iné. Čím viac je snark nezafarbiteľný, tým ťažšie je overiť, že spĺňa tú-ktorú hypotézu. Cieľom dizertačnej práce je dosiahnuť nové výsledky týkajúce sa mier nezafarbiteľnosti kubických grafov ako aj vzťahov medzi nimi. Výsledky môžu mať štruktúrally, konštrukčný aj výpočtový charakter.

Every cubic graph can be edge-coloured with three or four colours in such a way that adjacent edges receive distinct colours. Uncolourable cubic graphs (known as snarks) play a key role as potential counter-examples to several important and long-standing conjectures in discrete mathematics. There exist various measures of uncolourability of cubic graphs, e.g. oddness, resistance, perfect matching index, and others. The more is a snark uncolourable, the harder is to prove that it satisfies a conjecture in question. The aim of the dissertation is to obtain new results concerning the measures of uncolourability of cubic graphs and relationships between them. Results may have structural, construction, and computational character.

Cieľ / Aim*Cutting-edge research in graph theory*

Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Neurálno-symbolické techniky v reprezentácii znalostí

Neural-symbolic reasoning techniques in knowledge representation

Jazyk záverečnej práce / *Language of Thesis*

anglický / *English*

Školiteľ / *Tutor*

doc. RNDr. Martin Homola, PhD.

Anotácia / *Annotation*

Neurálno-symbolické techniky kombinujú strojové učenie a symbolické metódy UI ako je napr. logika. Tento kombinovaný prístup umožňuje napr. hľadanie vysvetlení prečo bol nejaký výsledok odvodený, zatiaľ čo metódy strojového učenia takéto vysvetlenia typicky neumožňujú.

Neural-symbolic reasoning combines machine learning with symbolic AI approaches such as logic. Neural-symbolic methods are able provide explanations why such and such results are derived and can thus improve pure machine learning techniques which often do not allow any form of explanations.

Cieľ / *Aim*

Aplikácia neurálno-symbolických metód na rôzne problémy v reprezentácii znalostí.

Application of neural-symbolic reasoning methods on various problems in knowledge representation.

Literatúra / *Literature*

[1] Garcez, A.D.A., Gori, M., Lamb, L.C., Serafini, L., Spranger, M. and Tran, S.N., 2019. Neural-Symbolic Computing: An Effective Methodology for Principled Integration of Machine Learning and Reasoning. arXiv preprint arXiv:1905.06088. [2] Besold, T.R., Garcez, A.D.A., Bader, S., Bowman, H., Domingos, P., Hitzler, P., Kühnberger, K.U., Lamb, L.C., Lowd, D., Lima, P.M.V. and de Penning, L., 2017. Neural-symbolic learning and reasoning: A survey and interpretation. arXiv preprint arXiv:1711.03902. [3] Hitzler, P., Bianchi, F., Ebrahimi, M. and Sarker, M.K., 2019. Neural-symbolic integration and the Semantic Web. *Semantic Web*

*[1] Garcez, A.D.A., Gori, M., Lamb, L.C., Serafini, L., Spranger, M. and Tran, S.N., 2019. Neural-Symbolic Computing: An Effective Methodology for Principled Integration of Machine Learning and Reasoning. arXiv preprint arXiv:1905.06088. [2] Besold, T.R., Garcez, A.D.A., Bader, S., Bowman, H., Domingos, P., Hitzler, P., Kühnberger, K.U., Lamb, L.C., Lowd, D., Lima, P.M.V. and de Penning, L., 2017. Neural-symbolic learning and reasoning: A survey and interpretation. arXiv preprint arXiv:1711.03902. [3] Hitzler, P., Bianchi, F., Ebrahimi, M. and Sarker, M.K., 2019. Neural-symbolic integration and the Semantic Web. *Semantic Web**

Študijný program / Study programme:

Informatika / Computer Science

Názov / Title

Poradná zložitosť v modeloch výpočtov
Advice complexity of computational models

Jazyk záverečnej práce / Language of Thesis

anglický / English

Školiteľ / Tutor

prof. RNDr. Rastislav Kráľovič, PhD.

Anotácia / Annotation

In several areas of theoretical computer science the hardness of performing a computational task stems from the unavailability of some information about the input. E.g. in online algorithms, the output must be constructed incrementally without the knowledge of the future input; in distributed computing, the processors may only have a local view of the communication network; in streaming algorithms, the algorithm is only allowed to read the input once with a very limited memory. In such cases, extensive research effort has been invested into identifying which properties are important for the problem at hand. Traditionally a qualitative approach has been used, analyzing the impact of particular types of information (e.g. What happens if the processes know the diameter of the topology? What if the online scheduling algorithm knows the maximum length of a job?). In the recent decade a quantitative approach was introduced, where the question is What happens if the algorithm/process is allowed to have a short but otherwise arbitrary information (advice) about the unknown part? The general direction of the thesis is in investigating the advice complexity in (some of the) settings mentioned above. It is a general framework that will be made into a specific proposal after being tailored to the particular interests of the student after personal consultation.

Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Simulácia kotaktov s anizotropickým trením v prípade kolízie viacerých tuhých telies
Rigid Body Simulation of Multibody System with Contact Anisotropic Friction

Jazyk záverečnej práce / *Language of Thesis*

anglický / *English*

Školiteľ / *Tutor*

prof. RNDr. Roman Ďurikovič, PhD.

Anotácia / *Annotation*

Existuje stále rastúca požiadavka preklenúť skutočnú medzeru, ktorá existuje medzi simuláciami počítačovej grafiky a skutočným svetom. Presné modelovanie fyzického správania objektov v reálnom svete je tu hlavným problémom a v kontexte tohto výskumného návrhu máme konkrétny záujem o fyzikálne vlastnosti, ktoré súvisia s drsnosťou povrchu, ako je napríklad trenie. To predstavuje zaujímavú výskumnú príležitosť, ktorá leží na križovatke zobrazovania počítačovej grafiky a dynamickej simulácie. Preto je našou motiváciou nielen zlepšiť trecie modely pre dynamické simulácie v reálnom čase, ale aj preklenúť medzeru medzi modelmi odrazovej plochy a trením znázornením mapovania, ktoré je založené na drsnosti povrchu. To neposkytuje len konzistenciu medzi vzhľadom povrchu a jeho fyzickým správaním v simuláciách, ale ponúka možnosť lepšieho odôvodňovania robotiky a aplikácií počítačového videnia. B. / B.1 Pozadie a odôvodnenie Trenie je kľúčovým konceptom v centre tohto výskumného návrhu. Vo fyzikálnej simulácii sa zvyčajne modeluje ako záťažovo závislá zložka, ktorá je úmerná normálnej sile medzi dvoma kontaktovanými povrchmi. Populárnym príkladom je tzv. Coulombovo trenie, kde prípustné trecie sily sú riadené nerovnosťou, ktorá vypočíta prípustné trecie sily F koeficientom trenia a normálnou silou f_n . Výber koeficientu trenia je dôležitý pre realizáciu fyzicky prijateľného správania a pre mnoho aplikácií to znamená preddefinovanie hodnoty μ pre každý pár materiálov v simulácii. To spôsobuje problémy v štádiách návrhu a modelovania, pretože používateľ je nútený použiť existujúcu tabuľku empiricky určených hodnôt [1] alebo vykonať merania na určenie koeficientu trenia pre nový materiál a každý ďalší materiál v tabuľke, ktorý je nákladné. Navyše, Coulombové trenie a súvisiace modely nedokážu zachytiť nelinearitu a stochastickú povahu povrchových interakcií v dôsledku drsnosti v makro a mikrosnímkach, čo samozrejme ovplyvňuje realizmus.

There is an ever increasing demand to bridge the reality gap that exists between computer graphics simulations and the real-world. Accurately modeling the physical behaviour of real-world objects is a central concern here, and within the context of this research proposal we are specifically interested in physical properties that relate to the roughness of surfaces, such as friction. This presents an interesting research opportunity, which lies at the intersection of computer graphics rendering and dynamical simulation. Therefore, our motivation is to not only improve friction models for real-time dynamical simulations, but to also bridge the gap between surface reflectance and friction models by learning a mapping which is based on surface roughness. This will not only provide consistency between the appearance of a surface and its physical behaviour in simulations, but offers the possibility of improved reasoning for robotics and computer vision applications. B. / B.1 Background and rationale Friction is a key concept at the center of this research proposal. In physics simulation, it is typically modeled as a load-dependent component that is proportional to the normal force between two surfaces in contact. A popular example of this is Coulomb friction, where permissible frictional forces are governed by the inequality, which computes permissible friction forces F by the friction coefficient and normal force. Choosing the friction coefficient here

is important for realizing physically plausible behaviour, and for many applications, this means predefining the value for each pair of materials in the simulation. This causes problems during design and modeling stages, since the user is constrained to use an existing table of empirically determined values [1], or perform measurements to determine the coefficient of friction for the new material and every other material in the table, which is costly. Furthermore, Coulomb friction and related models fail to capture the non-linearities and stochastic nature of surface interactions due to roughness at macro- and micro-scales, which obviously impacts realism.

Cieľ / Aim

O1. Vytvorte generalizovaný model trenia, ktorý je parametrizovaný pomocou prvkov drsnosti pre dvojicu povrchov. O2. Otestujte modely trenia tým, že skenujete povrchy v reálnom svete a porovnáte chovanie typu "stick-slip" v simuláciách versus experimenty v reálnom svete. O3. Naučte systém zobrazenie medzi mikroštruktúrou BRDF a vyvinutým modelom trenia. Možno očakávať, že výsledky dizertácie budú publikovateľné v časopisoch, ktoré pokrýva databáza Mathematical Reviews a zároveň databáza SCOPUS, napríklad v JAMSI, IEEE ICPR, IEEE CG, Radioengineering, CASA konferencia, MEIS Fukuoka.

O1. Develop a generalized friction model that is parameterized by roughness features for a pair of surfaces. The model will efficiently compute friction forces and be integrated as part of a real-time multibody simulation framework. O2. Validate the friction models by scanning real-world surfaces and comparing the stick-slip behaviour of the simulations versus real world experiments. O3. Learn a mapping between micro-facet BRDFs and the developed friction model, thus closing the loop on rendering and dynamical simulations. Objectives in more detail follow. Investigate the Friction from roughness. Friction is mainly due to asperities on the surface of objects bumping against each other caused by relative motion [10]. However, it is rarely modeled explicitly in terms of the surface roughness. Exceptionally, Ogilvy [11] predicted friction forces based on roughness of two surfaces using elastic deformation of asperities and the resulting contact model estimates friction forces at both a microscopic and macroscopic model. Karpenko and Akay [12] further proposed a method for computing friction forces based on the surface roughness and relative orientation of two surfaces, which accounts for anisotropy. These promising works make progress towards improved models and a fundamental understanding of friction based on surface roughness. However, unlike our "proposed" research, they are not suitable for real-time simulation, where efficiency is a concern. Roughness in image synthesis. Micro-facet BRDFs are able to reproduce a wide-range of reflectance phenomena related to surface roughness, which results in photorealistic rendering of real-world objects. Micro-facet BRDFs assume that surfaces are rough at a fine scale and well-described by a collection of facets with some distribution D of size and direction, and a geometry term G that describe how much a micro-facet is blocked, or shadowed, by neighbouring micro-facets. Learning from photorealistic images. The importance of physically based rendering methods is emphasized by the fact that synthetic image datasets generated by commercial video game engines are increasingly being used to train high-capacity machine learning methods for robotic and autonomous applications [14, 15], since the game engines are used because they are efficient, easy to use, and plausible. However, researchers in the robotics and computer vision community have also encountered the reality gap problem introduced by video game renderers. Various approaches have been devised to overcome these shortcomings, e.g. domain adaptation [16] [17]. Recent work by Zhang et al. [18] has similar goals to our proposal. They learn a correspondence between reflectance disks, which are embodiments of the micro-facet BRDF, and a friction coefficient. However, their approach is quite limited in that it essentially maps between a rendered image and the friction coefficient for a single material. Nevertheless, their findings make significant progress towards improved physical reasoning for computer vision-based learning. We therefore aim to further advance this research direction by learning correspondences between friction and the visual appearance based on a fundamental underlying property of the

surface: roughness. Bridge the Dynamic Simulation and Rendering. Finally, we recognize that surface roughness is the focus of tribology, a multidisciplinary field dedicated to the study of friction. Although some frictional effects can be attributed to molecular-level electromagnetic forces between surfaces, we focus on friction due to micro-scale asperities since these are more appropriate for our intended applications.

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Klíčové slová / Keywords

computer graphics, simulation, surface roughness, friction rendering machine learning
computer graphics, simulation, surface roughness, friction rendering machine learning

Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Simulácia veľkých rozmerov dynamiky viacerých kvapalín s pohyblivými prekážkami.
Large Scale Simulations for Multiple Fluid Dynamics With Moving Interfaces

Jazyk záverečnej práce / *Language of Thesis*

anglický / *English*

Školiteľ / *Tutor*

prof. RNDr. Roman Ďurikovič, PhD.

Anotácia / *Annotation*

Coupling 2D and 3D Simulation in a Lagrangian Way A 2D simulation based on the SWE is often used to simulate large bodies of water. Although a real-time simulation can be achieved \cite{Hagen05} various limitations result from the 2D nature of the simulation. Because a height field is used to represent the fluid no complex effects, like drops, splashes or breaking waves, might be simulated. One simply solution is to add uncoupled particles to the simulation like in \cite{Chentanez10}, where sprays, foam, and waterfalls were simulated by generating uncoupled particles and interaction between these particles and the height filed was handled. Simulation of breaking waves was achieved by adding fluid sheets in \cite{Thurey07}. A full coupling of 2D and 3D simulation was presented in \cite{Thurey06} using lattice Boltzmann method. Even better results were achieved in \cite{Chentanez11}, where the approach from \cite{Irving06} was enhanced. A combination of tall cells and 3d grid cells was employed to simulate water in real-time. Although good results were achieved using the previously mentioned methods all handle the fluid in Eulerian way. We would like to couple SPH-based shallow water simulation with a full 3D SPH simulation. The use of SPH for both the 2D and the 3D simulation gives a fully Lagrangian approach. The 3D simulation will be used only near the fluid surface where the complex effect with high visual impact occur. Therefore the most of the fluid domain will be simulated with a fast 2D approach and a fast simulation should be achieved. Erosion Process and Fluid Mixing in 2D SPH We would like to add advection of concentrations between particles to SPH-based shallow water simulation. A 2D representation of the fluid can not fully capture the diffusion and sedimentation processes in the fluid. Therefore we will create new particles by dividing every fluid particle to multiple particles in the vertical direction. These particles will move together in the fluid simulation and will be taken in the computation as a single particle. In the mixing process, where concentrations will be advected, the created particles will be handled as separate particles and carry the dissolved material. The proposed approach to fluid mixing can be exploited in the erosion process as well as in mixing of several fluids. Because several subsamples of dissolved material are stored for every simulation particle a volumetric raytracing can be performed. A realistic visualization of the erosion precess can be acquired in this way. Multiresolution Simulation A multiresolution simulation is usually used to enhance the efficiency of the simulation. In \cite{Adams07} a 3 to 8-times speedup was achieved. Several concepts of particle merging and splitting were used in the resampling process. From two \cite{Adams07} to several particles \cite{Desbrun99} were merged and split. Virtual particles were used in \cite{Keiser06}. Different criterion for particle merging and splitting were used as well. The speed of the deformation was used in \cite{Desbrun99} and the geometrical complexity was used in \cite{Adams07}. A different approach was proposed in \cite{Cohen10}. A translating Eulerian grid was used to to concentrate the computation into important regions and the rest was simulated by particles. This concept can be taken as a level of detail approach as well as the solution from \cite{Solenthaler11}, where a high resolution simulation was used to capture the regions of interest. We would like to employ

the multiresolution simulation to concentrate the computation into region of visual importance. A higher-resolution simulation will be used in this regions. Such regions are the regions where an interaction between fluid and solid occurs. Another criterion will be view dependent criterion based on the field of view of the camera and the distance from the camera. It is difficult to say which resampling solution will perform best for a 2D particle-based simulation. Because of that we will try several solutions and employ the one with best trade-off between speed and stability. Enhancing Sampling of the Fluid A low sampling of the fluid can result in visual artifacts. To resolve this problem in \cite{Ando11} particles were added in the thin fluid regions to prevent rupturing of this regions. A particle was added among two candidate particles and the physical properties were redistributed between the created and candidate particles. This method is employed for the PIC/FLIP method and no such resampling is needed for the 3D SPH because such problem do not occur here.

Coupling 2D and 3D Simulation in a Lagrangian Way A 2D simulation based on the SWE is often used to simulate large bodies of water. Although a real-time simulation can be achieved \cite{Hagen05} various limitations result from the 2D nature of the simulation. Because a height field is used to represent the fluid no complex effects, like drops, splashes or breaking waves, might be simulated. One simple solution is to add uncoupled particles to the simulation like in \cite{Chentanez10}, where sprays, foam, and waterfalls were simulated by generating uncoupled particles and interaction between these particles and the height field was handled. Simulation of breaking waves was achieved by adding fluid sheets in \cite{Thurey07}. A full coupling of 2D and 3D simulation was presented in \cite{Thurey06} using lattice Boltzmann method. Even better results were achieved in \cite{Chentanez11}, where the approach from \cite{Irving06} was enhanced. A combination of tall cells and 3d grid cells was employed to simulate water in real-time. Although good results were achieved using the previously mentioned methods all handle the fluid in Eulerian way. We would like to couple SPH-based shallow water simulation with a full 3D SPH simulation. The use of SPH for both the 2D and the 3D simulation gives a fully Lagrangian approach. The 3D simulation will be used only near the fluid surface where the complex effect with high visual impact occur. Therefore the most of the fluid domain will be simulated with a fast 2D approach and a fast simulation should be achieved. *Erosion Process and Fluid Mixing in 2D SPH* We would like to add advection of concentrations between particles to SPH-based shallow water simulation. A 2D representation of the fluid can not fully capture the diffusion and sedimentation processes in the fluid. Therefore we will create new particles by dividing every fluid particle to multiple particles in the vertical direction. These particles will move together in the fluid simulation and will be taken in the computation as a single particle. In the mixing process, where concentrations will be advected, the created particles will be handled as separate particles and carry the dissolved material. The proposed approach to fluid mixing can be exploited in the erosion process as well as in mixing of several fluids. Because several subsamples of dissolved material are stored for every simulation particle a volumetric raytracing can be performed. A realistic visualization of the erosion process can be acquired in this way. *Multiresolution Simulation* A multiresolution simulation is usually used to enhance the efficiency of the simulation. In \cite{Adams07} a 3 to 8-times speedup was achieved. Several concepts of particle merging and splitting were used in the resampling process. From two \cite{Adams07} to several particles \cite{Desbrun99} were merged and split. Virtual particles were used in \cite{Keiser06}. Different criterion for particle merging and splitting were used as well. The speed of the deformation was used in \cite{Desbrun99} and the geometrical complexity was used in \cite{Adams07}. A different approach was proposed in \cite{Cohen10}. A translating Eulerian grid was used to concentrate the computation into important regions and the rest was simulated by particles. This concept can be taken as a level of detail approach as well as the solution from \cite{Solenthaler11}, where a high resolution simulation was used to capture the regions of interest. We would like to employ the multiresolution simulation to concentrate the computation into region

of visual importance. A higher-resolution simulation will be used in these regions. Such regions are the regions where an interaction between fluid and solid occurs. Another criterion will be view dependent criterion based on the field of view of the camera and the distance from the camera. It is difficult to say which resampling solution will perform best for a 2D particle-based simulation. Because of that we will try several solutions and employ the one with best trade-off between speed and stability. Enhancing Sampling of the Fluid A low sampling of the fluid can result in visual artifacts. To resolve this problem in \cite{Ando11} particles were added in the thin fluid regions to prevent rupturing of these regions. A particle was added among two candidate particles and the physical properties were redistributed between the created and candidate particles. This method is employed for the PIC/FLIP method and no such resampling is needed for the 3D SPH because such problem do not occur here.

Ciel' / Aim

1. SPH optimization for large fluid dynamics simulation. 2. Study and implement the SPH method implement the terrain as a granular material with different properties. 3. Study the sea dynamics movement.

1. SPH optimization for large fluid dynamics simulation. 2. Study and implement the SPH method implement the terrain as a granular material with different properties. 3. Study the sea dynamics movement.

Literatúra / Literature

Minimálne 100 článkov SIGGRAPH, CASA, EG. [1] Lee, H., and Han, S. Solving the shallow water equations using 2d sph particles for interactive applications. Visual Computer 26 (June 2010), 865, 872. [2] Solenthaler, B., and Gross, M. Two-scale particle simulation. ACM Trans. Graph. 30 (Aug. 2011), 81:1, 81:8. and other SIGGRAPH and CSA papers.

At least 100 recent papers from SIGGRAPH a CASA conferences. Starting papers are following: [1] Lee, H., and Han, S. Solving the shallow water equations using 2d sph particles for interactive applications. Visual Computer 26 (June 2010), 865, 872. [2] Solenthaler, B., and Gross, M. Two-scale particle simulation. ACM Trans. Graph. 30 (Aug. 2011), 81:1, 81:8. and other SIGGRAPH and CSA papers.

Poznámka / Comment

Možno očakávať, že výsledky dizertácie budú publikovateľné v časopisoch, ktoré pokrýva databáza Mathematical Reviews alebo databáza SCOPUS, SCI napríklad v Computer Graphics Forum, Shape modeling, The Arabian Journal for Science and Engineering, a konferenciách IEEE Information Visualization, ACM SCCG.

Expected publication in scientific journals SCOPUS, SCI for example v Computer Graphics Forum, Shape modeling, The Arabian Journal for Science and Engineering, IEEE Information Visualization, ACM SCCG.

Kľúčové slová / Keywords

large fluid simulation, smoothed particle hydrodynamics, shallow water equation, fluid surface, boundary handling

large fluid simulation, smoothed particle hydrodynamics, shallow water equation, fluid surface, boundary handling

Študijný program / Study programme:

Informatika / Computer Science

Názov / Title

Smerom k vteleným inteligentným agentom so sebauvedomením

Towards self-aware embodied intelligent agents

Jazyk záverečnej práce / Language of Thesis

anglický / English

Školiteľ / Tutor

prof. Ing. Igor Farkaš, Dr.

Anotácia / Annotation

Embodied cognition approach to building intelligent artificial agents entails that having a body is crucial for acquiring knowledge during agent's interactions with the world. Information about one's own body (body schema) is crucial for the agent, and it consists of various components, including sensory-motor prediction, self-other distinctions, spatial knowledge and others.

Cieľ / Aim

1. Design an embodied robotic architecture that will satisfy minimal criteria for a self-aware embodied agent based on neural networks. 2. Train the model and test its functionality in a robotic toy world.

Literatúra / Literature

M. Hoffmann et al: Body Schema in Robotics: A Review. IEEE Transactions on Autonomous Mental Development, 2010, https://www.researchgate.net/publication/224182540_Body_Schema_in_Robotics_A_Review G. Schillaci, V. Hafner, B. Lara: Exploration Behaviors, Body Representations, and Simulation Processes for the Development of Cognition in Artificial Agents. Frontiers in Robotics and AI, 2016, <https://doi.org/10.3389/frobt.2016.00039> P. Vicente, L. Jamone, A. Bernardino: Online Body Schema Adaptation Based on Internal Mental Simulation and Multisensory Feedback, Frontiers in Robotics and AI, 2016, <https://doi.org/10.3389/frobt.2016.00007>

Študijný program / Study programme:Informatika / Computer Science

Názov / Title

Učenie úloh s pozornosťou

*Task learning with attention***Jazyk záverečnej práce / Language of Thesis**

anglický / English

Školiteľ / Tutor

prof. Ing. Igor Farkaš, Dr.

Anotácia / Annotation

Recent work on machine learning started to exploit mechanisms of attention, that are known to be crucial for animals, helping them to solve various pattern recognition and motor tasks. Attention serves as a top-down tunable filter that helps the organism to focus on a subset of inputs, hence speeding up and facilitating subsequent information processing. Literature already provides several algorithms that were designed and successfully tested in artificial learning systems. Additional benefit of attention, yet unexplored, lies in building conscious agents, that are expected to possess an even larger cognitive potential, based on interactions between lower (faster, unconscious) and higher (slower, conscious) subsystems during solving various tasks.

Cieľ / Aim

1. Design a new algorithm for a neural network incorporating an attention mechanism, or a modification of an existing model, and test its functionality on a selected cognitive task. 2. Analyze the behaviour of the functioning algorithms, and compare it to related models.

Literatúra / Literature

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Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Univerzálny autonómny transportný systém ATS na inteligentnej vozovke
The Universal Autonomous Transport System ATS

Jazyk záverečnej práce / *Language of Thesis*

anglický / *English*

Školiteľ / *Tutor*

prof. RNDr. Roman Ďurikovič, PhD.

Anotácia / *Annotation*

: Automatické dopravné systémy v ohraničenom priestore Ich charakteristickou črtou je použitie výhradne len autonómnych vozidiel a vylúčenie vodičov z ohraničeného priestoru, čo privedie k zvýšeniu poriadku v doprave a výraznému zníženiu počtu dopravných nehôd. Najpokročilejším v tejto kategórii je systém Public Rapid Transport (PRT) od britskej firmy Ultra Global Ltd., ktorý vozi pasažierov na letisku Heathrow od roku 2011 a má pripravených mnoho projektov po celom svete. Existujúce a pripravované systémy tejto kategórie však neriešia dopravu komplexne, ale len v určitých segmentoch dopravy, napr. len osobnú dopravu v špeciálnych vozidlách, alebo len nákladnú dopravu.

ATS requires that we develop a whole new technology “i-vehicles for i-roads” for computer-driven autonomous vehicles. The technology is based on the information interaction between the local navigation system of an on-board computer in the i-vehicle, and passive identifiers on a reconditioned road - the i-road. One of the most important objectives of the ATS introduction as the new transport system is a significant increase in traffic safety. Our goal is a ten-fold reduction in the number of road accidents in the ATS compared with the current average rate of traffic accidents (assuming 100% deployment of computer-controlled vehicles inside the ATS confinement). This ambitious goal is based on the assumption that about 95% of road accidents are caused by drivers, and only a small percentage is a result of technical failures of vehicles. Transport in the ATS will be organized by the Central Control System (CCS). It will be set up in a way to minimize the possible collisions. The CCS will use such means as: strict adherence to the speed limit ruled for each section (curves, intersections, etc.) of the road. The CCS will also ensure smooth and fully controlled switching in between the lanes, thus virtually eliminating emergency situations when overtaking. With the ATS system, seat belt fastening will be mandatory; the vehicle will not move unless all the passengers have been fastened. ATS will eliminate effects of the weather as much as possible. For example, the Central Control System will limit the maximum speed of the vehicles according to the rainfall intensity. ATS developers plan to develop a highly sturdy reading device to receive the information from i-roads that would be as robust and weather proof as possible. Based on preliminary analyses, we plan to develop three-dimensional laser scanning identifiers, little or non-relevant to the water layer on their surface, which will be a few millimeters above the road surface. In the case of normal rainfall (any current traffic situation collapses during a flood situation, usually as a result of vehicle chain accidents) it will be possible to get a high-quality laser-scanned position of the identifier and receive the current vehicle position on the road from its data. The information on the vehicle position shall be read by the detector as many as 5,000 times per second. This way we can acquire a vast redundancy in the flow of information on the vehicle position, compared to the quantity of information on the vehicle position that drivers use nowadays. This suggests that if the vehicle has its location information available many times per second, even if half of this information gets lost, the safety and control of the vehicle movement is still fully sufficient.

Cieľ / Aim

A3 Bezpečnosť a spoľahlivosť pohybu systému v ATS (nezávislý výskum a vývoj) A3.1 Analýza súčasného stavu riešenia bezpečnosti a spoľahlivosti autonómnych vozidiel a autonómnych systémov vo svete. A3.2 Analýza externých rizík: výskyt ľudí, zvierat, alebo materiálu v dráhe vozidiel, vplyvy počasia, nečistôt na snímanie údajov z i-vozovky a okolia vozidla. A3.3 Analýza metód identifikácie externých prekážok (výskyt ľudí, zvierat, alebo materiálu v dráhe vozidiel) a metód reakcie systému. A3.4 Výskum metód na predchádzanie stretu s detegovanými prekážkami. A3.5 Výskum zabezpečenia optimálnej komunikácie medzi Bezpečnostným Systémom (BS) a ostatnými systémami vozidla (NS a riadiaci systém). A3.6 Analýza a výskum možností hardvérového riešenia BS. A3.7 Výskum riešenia bezpečnostného systému i-vozidla a jeho integrácie do i-vozidla. A3.8 Výskum vplyvov počasia na spoľahlivosť a bezpečnosť navigačného a bezpečnostného systému ATS A3.9 Implementácia metód bezpečnosti a spoľahlivosti v systéme ATS. A3.10 Integrácie metód bezpečnosti a spoľahlivosti do systému ATS. A3.11 Testovanie a overenie metód bezpečnosti a spoľahlivosti v systéme ATS. A1 Centrálny riadiaci systém, navigačný systém vozidla a možnosti integrácie ATS (základný výskum) A1.1 Analýza súčasného stavu podobných úloh vo svete. A1.2 Definícia požiadaviek a vypracovanie návrhu optimálneho riešenia riadenia systému ATS. A1.3 Výskum virtuálnej reprezentácie priestoru ATS pre centrálny počítač. A1.4 Výskum komplexného efektívneho riadenia dopravy v ATS centrálnym počítačom s rešpektovaním pravidiel dopravy. A1.5 Výskum efektívneho riešenia havarijných a nepredvídaných udalostí na úrovni ATS (blokovanie vozovky, úplná alebo čiastočná strata komunikácie a pod.). A1.6 Výskum efektívneho riadenia dopravy v ATS centrálnym počítačom so softvérom "operational management". A1.7 Vytvorenie virtuálneho modelu ATS a simulácia jeho funkčnosti s mnohými vozidlami v ohraničených areáloch. A1.8 Výskum zabezpečenia optimálnej komunikácie medzi NS a ostatnými systémami vozidla (bezpečnostný systém a riadiaci systém). A1.9 Výskum optimálnej navigácie vozidla riadeného riadiacim systémom. A1.10 Vývoj virtuálnej reprezentácie priestoru ATS pre NS. A1.11 Výskum metód na zabezpečenie dodržania bezpečných vzdialeností v bežnej premávke aj pri havarijných situáciách, automatického plynulého prechodu križovatiek a automatického radenia vozidiel a automatického parkovania. A1.12 Analýza a výskum možností hardwarového riešenia NS. A1.13 Výskum metód uchovania údajov pre potreby analýz v prípade nehody („čierna skrinka“).

The proposed ATS is a new universal autonomous comprehensive transport system, in which the industrially-manufactured electric vehicles of all types (cars, buses, trucks etc.) will be moving about within a bounded area on reconditioned existing roads, without drivers, and only guided by on-board computers. ATS is based on the original technology "intelligent vehicles on intelligent roads" designed by prof. Branislav Sitár. • Highly organized transport constantly controlled by a central control system • The system combines the benefits of individual mobility while maintaining the benefits of public transport • Modularity - local ATS systems can be easily combined into larger units The goals of continuous research on the project: A3 Safety and reliability of the ATS movement system (independent research and development) Analysis of the current status of safety and reliability of autonomous vehicles and autonomous systems in the world. Analysis of external risks: the prevalence of people, animals or materials in the course of the vehicle, weather conditions, dirt for the purposes of monitoring information on the i-road and around the vehicle. Analysis of methods for the identification of external obstacles (presence of humans, animals or materials in the vehicle) and methods of response. Research on methods of preventing collision with the detected obstacles. Research to ensure optimal communication between safety systems (BS) and other vehicle systems (NS and control system). The analysis and research into the hardware solution of safety systems. Research on the security system solution of the i-vehicle and its integration into the i-vehicle. Research on the effects of weather conditions on the reliability and safety of the navigation and security system of ATS

Literatúra / Literature

[1] Virtual assistants and self-driving cars - IEEE Conference Publication ieeexplore.ieee.org/document/7972192/ by G Lugano - 2017 [2] Increasing Fairness by Delegating Decisions to Autonomous Agents www.ifaamas.org/Proceedings/aamas2017/pdfs/p419.pdf May 8, 2017 [3] Towards social autonomous vehicles: Efficient collision avoidance ... journals.plos.org/plosone/article?id=10.1371/journal.pone.0186103 by F Riaz - 2017 [4] Proceedings of the 16th Conference on Autonomous Agents and ... dl.acm.org/citation.cfm?id=3091125 May 12, 2017 - AAMAS 2017 [5] Designing Autonomous Vehicles - arXiv <https://arxiv.org/pdf/1708.01925> by F Riaz - 2017 [6] A Rational Agent Controlling an Autonomous Vehicle: Implementation ... <https://arxiv.org/abs/1708.01925> by LER Fernandes - 2017 Mnohé svetové firmy (Google, GM, Ford, Tesla, BMW, Merceds Benz) a ďalšie automobilky v tomto smere už intenzívne pracujú. Na bežné vozidlá pripevnia optické kamery, radary a lidary a palubnými počítačmi riadia vozidlá po obyčajných vozovkách. Tento systém je relatívne málo efektívny, drahý a pomalý. Je otázne, kto bude kupovať počítačom riadené vozidlo, ak bude 2-3 krát drahšie ako bežné auto. Súčasné používanie bezpilotných vozidiel spolu s vozidlami riadenými vodičmi, ktoré medzi sebou nekomunikujú, môže skôr zvýšiť chaos na cestách a tým aj počet dopravných nehôd. Študent si naštuduje a urobí prehľad v priemyselnej oblasti a u konkurencie, zároveň naštuduje odborné články IEEE CS z oblasti riadenia, komunikácie a strojového učenia. Minimálne 100 článkov

[1] Virtual assistants and self-driving cars - IEEE Conference Publication ieeexplore.ieee.org/document/7972192/ by G Lugano - 2017 [2] Increasing Fairness by Delegating Decisions to Autonomous Agents www.ifaamas.org/Proceedings/aamas2017/pdfs/p419.pdf May 8, 2017 [3] Towards social autonomous vehicles: Efficient collision avoidance ... journals.plos.org/plosone/article?id=10.1371/journal.pone.0186103 by F Riaz - 2017 [4] Proceedings of the 16th Conference on Autonomous Agents and ... dl.acm.org/citation.cfm?id=3091125 May 12, 2017 - AAMAS 2017 [5] Designing Autonomous Vehicles - arXiv <https://arxiv.org/pdf/1708.01925> by F Riaz - 2017 [6] A Rational Agent Controlling an Autonomous Vehicle: Implementation ... <https://arxiv.org/abs/1708.01925> by LER Fernandes - 2017 Machine learning research papers from IEEE database. At least 100 recent papers related to autonomous agents and autonomous cars.

Poznámka / Comment

Výsledky práce budú publikované v karentovanom časopise a zahraničných časopisoch ako sú JAMSI, IEEE Information Visualization, IEEE Transport systems.

Applicant is expected to publish the WoS journal publications and present the results at international conferences such as JAMSI, IEEE Information Visualization, IEEE Transport systems, local conference Aplimat or other related to the topic.

Kľúčové slová / Keywords

autonómne autá, inteligentná vozovka
Autonomous cars, intelligent road

Študijný program / Study programme:

Informatika / Computer Science

Názov / Title

Usudzovacie algoritmy pre ontológie a deskripčné logiky
Reasoning algorithms for ontologies and description logics

Jazyk záverečnej práce / Language of Thesis

anglický / English

Školiteľ / Tutor

doc. RNDr. Martin Homola, PhD.

Anotácia / Annotation

Cieľom práce je skúmať inovatívne inferenčné techniky pre deskripčné logiky, vrátane možnosti sústrediť sa na hybridné techniky ktoré kombinujú symbolickú inferenciu so strojovým učením.
The of this thesis is to explore novel reasoning techniques for description logics, including possibly hybrid reasoning techniques combining symbolic reasoning with machine learning.

Cieľ / Aim

Konkrétne ciele budú stanovené s prihliadnutím na výskumné záujmy uchádzača.
Particular goals will be set considering also the preference of the applicant.

Študijný program / Study programme:Informatika / *Computer Science*

Názov / TitleVýpočtová dekonvolúcia faktorov prispievajúcich ku skleróze multiplex
*Computational deconvolution of factors contributing to multiple sclerosis***Jazyk záverečnej práce / Language of Thesis**anglický / *English***Školiteľ / Tutor**

doc. Mgr. Bronislava Brejová, PhD.

Anotácia / Annotation

Skleróza multiplex (MS) je rozšírené ochorenie centrálnej nervovej sústavy. Študent využije súvisiace dáta z prietokovej cytometrie a zo sekvenovania RNA jednotlivých imunitných buniek z pacientov trpiacich MS a zdravých osôb na dekonvolúciu profilu génovej expresie, identifikáciu rozdielov v týchto profiloch a koreláciu nájdených rozdielov s biomarkermi stupňa závažnosti MS. Konzultantkou dizertačnej práce bude dr. Bibiana Bieleková z Národných ústavov alergie a infekčných chorôb v USA.

Multiple sclerosis (MS) is the most common immune-mediated disorder of the brain and spinal cord. The student will use matched flow cytometry data and single-cell RNA sequencing data of immune cells to deconvolute RNA signature in MS patients and controls to discover differences in transcriptomic signatures and correlate the identified differences with clinical and imaging biomarkers of MS severity. The thesis will be co-supervised by Dr. Bibiana Bieleková from the National Institutes of Allergy and Infectious Diseases, USA.

Študijný program / Study programme:

Informatika / *Computer Science*

Názov / Title

Výpočtové metódy na spracovanie genomických dát
Computational methods for processing genomic data

Jazyk záverečnej práce / Language of Thesis

anglický / *English*

Školiteľ / Tutor

doc. Mgr. Bronislava Brejová, PhD.

Anotácia / Annotation

Moderné technológie sekvenovania DNA produkujú veľké množstvá dát, ktoré je potrebné výpočtovo spracovať, aby sme získali informácie užitočné v biológii, medicíne a ďalších oblastiach. Cieľom práce je vyvinúť nové modely a efektívne algoritmy na spracovanie týchto dát.

Modern DNA sequencing technologies produce large quantities of data which need to be analyzed computationally to yield insights useful for biology, medicine and other areas. The goal of the thesis is to develop new models and efficient algorithms for processing such data.

Študijný program / *Study programme:*

Informatika / *Computer Science*

Názov / *Title*

Využitie umelej inteligencie na automatizáciu spracovania a analýzy optických spektier
Utilization of artificial intelligence to automate processing and analysis of optical spectra

Jazyk záverečnej práce / *Language of Thesis*

slovenský / *Slovak*

Školiteľ / *Tutor*

prof. RNDr. Roman Ďurikovič, PhD.

Konzultant / *Consultant*

doc. Mgr. Peter Čermák, PhD.

Anotácia / *Annotation*

Modelovanie absorpčných alebo emisných optických spektier je vo veľa aplikáciách jedinou cestou ako dosiahnuť informácie o podstate rôznych dejov alebo zložení ťažko dostupných prostredí. Dobrým príkladom je analýza emisných spektier meteorov horiacich v atmosfére, kde zaznamenané optické spektrum predstavuje väčšinou jediný priamy zdroj informácií o ich zložení (hlavne v prípade ak meteor zhorí celý v atmosfére). Ďalším dobrým príkladom je štúdium zloženia atmosfér exoplanét. V oboch prípadoch je veľmi dôležitým faktorom ovplyvňujúcim presnosť výsledku voľba algoritmu spracovania nameraných spektier. Cieľom projektu je v prvej časti nadviazať na predchádzajúce výsledky pracoviska experimentálnej fyziky v oblasti modelovania a interpretácie atomárnych alebo molekulárnych optických spektier. Ide napríklad o vytvorenie programu na spracovanie emisných spektier dusíkových výbojov [1]. V predkladanom projekte sa budeme hlavne zaoberať vývojom programu na spracovanie a interpretáciu spektier meteorov. Pôjde o spektrá zaznamenané systémom AMOS v rámci projektu „Study of meteoroid composition by meteor spectroscopy and simulated ablation of meteorites“ podporeného programom ESA PECS. *In many applications, modeling of absorption or emission optical spectra is the only way to obtain information about the nature of various events or the composition of difficult to access environments. A good example is the analysis of emission spectra of meteors burning in the atmosphere, where the recorded optical spectrum is usually the only direct source of information about their composition (especially if the meteor burns whole in the atmosphere). Another good example is the study of the composition of exoplanet atmospheres. In both examples, a very important factor influencing the accuracy of the result is the choice of the algorithm for processing the measured spectra. The aim of the project is in the first part to build on previous results of experimental physics in the field of modeling and interpretation of atomic or molecular optical spectra. For example, the creation of a program for processing emission spectra of nitrogen discharges [1]. In this project we will mainly deal with the development of a program for processing and interpretation of meteor spectra. These will be the spectra recorded by the AMOS system within the project "Study of meteoroid composition by meteor spectroscopy and simulated ablation of meteorites" supported by ESA PECS.*

Cieľ / *Aim*

Cieľom projektu je vytvorenie algoritmu a zodpovedajúceho používateľského prostredia umožňujúceho: · strojové rozpoznanie rôznych zložiek optického spektra (napríklad rozlíšiť príspevky v spektre od študovaného deje od tých spôsobených zariadeniami použitými na pozorovanie) · použitím informácií o jednotlivých prvkoch uložených v spektroskopických databázach automaticky detegovať ich prítomnosť v spektre (kvalitatívna analýza) · na základe

predchádzajúcich informácií určiť zastúpenie jednotlivých elementov vo vzorke a fyzikálne podmienky (napr. teplotu a celkový tlak) skúmaného objektu (kvantitatívna analýza)

The aim of the project is to create an algorithm and a corresponding user environment enabling:

· Machine recognition of the various components of the optical spectrum (for example, to distinguish spectrum contributions from the studied event from those caused by the devices used for observation) · Automatically detect their presence in the spectrum (qualitative analysis) using information about individual elements stored in spectroscopic databases · On the basis of previous information, determine the representation of individual elements in the sample and the physical conditions (eg temperature and total pressure) of the examined object (quantitative analysis)

Literatúra / Literature

Minimálne 100 článkov IEEE, ACM SIGGRAPH, CASA, EG. [1] Čermák P, Annušová A, Rakovský J, Martišoviš V and Veis P 2018 Plasma Sources Sci. Technol. 27 055009. [2] Zhou, J., Huang, B., Yan, Z. et al. Emerging role of machine learning in light-matter interaction. Light Sci Appl 8, 84 (2019) doi:10.1038/s41377-019-0192-4 [3] Roman Ďurikovič, Vladimír Ďurikovič, Numerická matematika pre informatika, Riešené príklady v programe MATHEMATICA May 2011 Publisher: University of Saint Cyril and Metod Press, Trnava, Slovakia ISBN: 978-80-8105-271-2

At least 100 recent papers published by IEEE, ACM SIGGRAPH, CASA, EG. [1] Čermák P, Annušová A, Rakovský J, Martišoviš V and Veis P 2018 Plasma Sources Sci. Technol. 27 055009. [2] Zhou, J., Huang, B., Yan, Z. et al. Emerging role of machine learning in light-matter interaction. Light Sci Appl 8, 84 (2019) doi:10.1038/s41377-019-0192-4 [3] Roman Ďurikovič, Vladimír Ďurikovič, Numerická matematika pre informatika, Riešené príklady v programe MATHEMATICA May 2011 Publisher: University of Saint Cyril and Metod Press, Trnava, Slovakia ISBN: 978-80-8105-271-2

Poznámka / Comment

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Kľúčové slová / Keywords

optická spektroskopia, optimalizácia, strojové učenie
optical spectroscopy, optimization, machine learning

Študijný program / Study programme:Informatika / Computer Science

Názov / Title

Zlepšenie detekcia genomickej variability pomocou pangenómov
Improving detection of genomic variability by employing pangenomes

Jazyk záverečnej práce / Language of Thesis

anglický / English

Školiteľ / Tutor

doc. Mgr. Tomáš Vinař, PhD.

Konzultant / Consultant

Mgr. Jaroslav Budiš, PhD.

Anotácia / Annotation

Varianty v ľudskom genome sa tradične hľadajú pomocou porovnávania sekvenačných dát zo skúmaného jedinca s referenčným genomom. Nevýhodou tohto prístupu sú systematické skreslenia spôsobené sekvenciami chýbajúcimi v referencii. Jedným zo spôsobov, ako sa tomuto problému vyhnúť, je nahradenie jedného referenčného génu kolekciou vo forme pangenomického grafu reprezentujúceho variabilitu celej populácie. Cieľom práce je vyvinúť nové metódy na prácu s pangenomickými grafmi. Práca bude prebiehať v spolupráci s Dr. Jaroslavom Budišom z firmy Geneton, ktorá sa zaoberá výskumom a klinickými aplikáciami genomického sekvenovania.

Traditionally, variants in the human genome are identified by comparing sequencing data from the subject to the reference genome. The disadvantage of this approach is the systematic bias caused by the missing reference sequences. One way to avoid this problem is to replace a single reference genome with a collection of genomes in the form of a pangenomic graph representing population variability. The aim of this work is to develop new methods for working with pangenomic graphs. The work will be co-supervised by Dr. Jaroslav Budiš from the company Geneton, which is focused on research and clinical applications of genomic sequencing.