

Отчет на секция за 2016 г.

Секция: ПАРАЛЕЛНИ АЛГОРИТМИ

Ръководител: проф. дн Иван Димов

1. Публикационна дейност

1.1 Публикации, отпечатани през 2016 г.

- *Научни публикации, които са реферирани и индексирани в световната система за реферирание, индексирание и оценяване - излезли от печат*

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2. Belehaki, A., Kutiev, I., **Marinov, P.**, Tsagouri, A., Koutroumbas, K., Elias, P. Ionospheric Electron Density Perturbations during the 7-10 March 2012 Geomagnetic Storm Period. Advances in Space Research, Elsevier, 2016, ISSN:0273-1177, DOI:http://dx.doi.org/10.1016/j.asr.2016.11.031, ISI IF:1.409
3. Chernogorova, T., **Dimov, I.**, Vulkov, L. Coordinate Transformation Approach for Numerical Solution of Environmental Problems. Mathematical Problems in Meteorological Modelling, series Mathematics in Industry, 24, Springer International Publishing, 2016, ISBN:Print ISBN978-3-319-, ISSN:1612-3956, DOI:10.1007/978-3-319-40157-7_7, 117-127
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6. **Dimov, I. T.**, **Todorov, V.** Error Analysis of Biased Stochastic Algorithms for the Second Kind Fredholm Integral Equation. Innovative Approaches and Solutions in Advanced Intelligent Systems, Studies in Computational Intelligence, 648, Springer International Publishing, 2016, ISBN:978-3-319-32206-3, ISSN:1860-949X, DOI:10.1007/978-3-319-32207-0_1, 3-16. SJR:0.24
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9. **Fidanova S., Pop P.** An Improved Hybrid Ant-Local Search Algorithm for the Partition Graph Coloring Problem. *Computational and Applied Mathematics*, 293, Elsevier, 2016, ISSN:0377-0427, DOI:10.1016/j.cam.2015.04.030, 55-61. SJR:1.104, ISI IF:1.266
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- *Научни публикации, включени в издания с импакт фактор IF (Web Of Science) или импакт ранг SJR (SCOPUS) - излезли от печат*

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1.2. Редактирани сборници или тематични броеве на списания

№	вид на продукта	Категория	Наименование	Характеристики	Участници
1	Брой от списание	Международно	Efficient Numerical Methods for Large-scale Scientific Computations	Издателство: Elsevier, ISSN: 0377-0427	Zlatev, Z. - Гост-редактор Dimov, I. - Гост-редактор Lirkov, I. - Гост-редактор
2	Тематичен сборник	Международно	Recent Advances in Computational Optimization, Results of the Workshop on Computational Optimization WCO 2014	Издателство: Springer, ISBN: 978-3-319-21132-9	Fidanova S. - Гост-редактор
3	Тематичен сборник	Международно	Recent Advances in Computational Optimization, Results of the Workshop on Computational Optimization WCO 2015	Издателство: Springer, ISBN: 978-3-319-40131-7	Fidanova S. - Редактор
4	Сборник трудове от научен форум	Международно	Conference Proceedings and Abstracts. XVII-th International Summer Conference on Probability and Statistics	Издателство: Institute of Mathematics and Informatics, Sofia, ISBN: 978-954-8986-46-5	Stoimenova, E. - Редактор Вojkova, M. - Редактор

1.4. *Цитати и/или отзиви, публикувани през 2016 г. с изключени самоцитати*

Брой цитирани публикации: 109

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Цумупа се в:

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Аналитичен отчет на секция за 2016 г.

2.1 Полза / ефект за обществото от извършваните дейности

Методите Монте Карло се смятат за най-надеждните методи за моделиране на електронен пренос в полупроводници, както и за решаване на сложни задачи със строги ограничения. През последните години при моделирането на устройства се налагат толкова малки скали по отношение на пространството и времето, че протичащите процеси не биха могли да се разглеждат като полупроводников транспорт и затова е необходима квантова интерпретация.

Разработени бяха нови оптимизирани паралелни реализации на Датския Ойлеров модел за пренос на замърсители във въздуха. Чрез този модел се прави оценка на концентрациите на голям брой атмосферни замърсители за дълъг период от време (една или няколко години) на базата на метеорологичните условия, както и на географското разпределение на източниците на замърсяване и техните емисии. Проведени бяха редица експерименти с адаптираната за съответния хардуер версия на Датския Ойлеров модел (UNI-DEM) върху

високопроизводителния клъстър на IBM в Барселона – MareNostrum III. Численото решаване на такъв голям и сложен математически модел се основава на разцепването на изходната система от частни диференциални уравнения на няколко по-прости системи въз основа на основните физически и химически процеси, представени в нея чрез адитивни членове. Въз основа на модела UNI-DEM бе създадена специализираната версия за анализ на чувствителността на Датския Ойлеров модел (SA-DEM). Демонстрирана бе висока паралелната ефективност и скалируемост на алгоритъма, особено при използване на най-фината дискретизационна мрежа на областта (480 x 480). Това е от важно значение за получаването на по-прецизни резултати при практическото използване на модела, особено в по-малки по площ страни в Европа, каквато е и България. Тези разработки са свързани с проект, финансиран от Фонда за научни изследвания, с ръководител за първи етап проф. Иван Димов.

Разработвани са метаевристични и стохастични методи за оптимизационни задачи, идващи от реалния живот и икономиката. Тези методи са прилагани към задачи за управление на ресурси, което води до оптимално използване на налични ресурси при отчитане на ограничения; оптимално управление на GPS мрежи и от там подобряване на предлаганата услуга; моделиране на биореактор за лекарствени субстанции, резултатите могат да се използват за оптимална настройка на работата на биореактор и от там за понижаване на цената на получените лекарствени субстанции. Приложен е интеркритериален анализ върху разработените алгоритми. Целта е намиране на степента на свързаност между отделните критерии при решаването на дадена задача и нейното опростяване, без това да води до влошаване на получените резултати, а от там и повишаване на бързодействието при внедряване на съответните алгоритми. Тези разработки са свързани с два проекта, финансирани от Фонда за научни изследвания.

Разработен е модел на базата на игровото моделиране за симулиране на горски и полски пожари. Освен влиянието на вятъра, е въведено и влиянието на терена върху разпространението на пожара. Изследвано е изменението на фронта на пожара при разнообразно разпределение на горимите материали в изследваната област.

Предложен е метод за тримерно моделиране на йонните концентрации. С помощта на този модел могат да се проследят измененията в йоносферата, предизвикани от слънчеви бури. Използваните данни са от наземни GPS станции и спътници.

Направена е обработка на данни и анализ на параметрите на кръвната плазма на различни групи пациенти. Приложен е интеркритериален и корелационен анализ на данните и са анализирани връзките между тях.

Обработени са данните от дълбочинни електроди, имплантирани на две породи плъхове. Изследвани са данни от четири фази на епилептичен пристъп. Подробно е изследван спектъра на измерените сигнали. На основа на проведеня анализ е направена хипотеза за това кои изменения в спектъра са предвестници на епилептичен пристъп.

Изследвани са свойствата на рангови критерии за две извадки. Дефиниран е клас от рангови критерии, обобщаващ рангов критерий на Шидак. Изследвано е разпределението на обобщения критерий при нулевата хипотеза и при Леманови алтернативи. Изследвана е мощността на критериите от класа. Критериите имат приложение при проверка на статистически хипотези, когато в данните се съдържат необичайни за модела наблюдения.

2.2. Взаимоотношения с институции

Членовете на секцията са представили общо 17 рецензии и становища за присъждане на научни степени и звания и 157 рецензии за научни издания.

Един член на колектива е участвал в комисия за акредитация на висши учебни заведения.

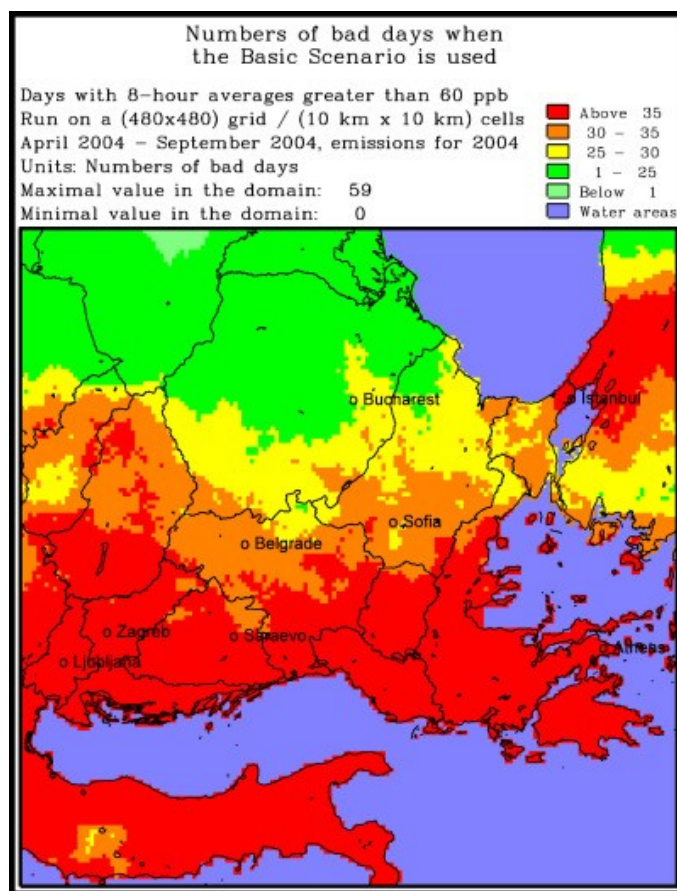
3. РЕЗУЛТАТИ ОТ НАУЧНАТА ДЕЙНОСТ ПРЕЗ 2016 г.:

3.1. Най-значимо научно-приложно постижение.

ЕФЕКТИВНИ МОНТ-КАРЛО АЛГОРИТМИ

Разработен е нов Вигнеров-Монте Карло модел за транспорт на заредени частици. Моделът дава възможност за независима формулировка на квантовата механика в термините на частици във фазовото пространство и намира широко приложение в нано-електрониката (за симулация на поведението на приборите в съвременните интегрални схеми), в нано-структури (за симулация на електронни състояния в молекули), както и при създаване на нови принципи за обработка на информация.

Разработени бяха нови оптимизирани паралелни реализации на Датския Ойлеров модел, базиран на Монте Карло метод за пренос на замърсители във въздуха. Чрез този модел се прави оценка на концентрациите на голям брой атмосферни замърсители за



дълъг период от време (една или няколко години) на базата на метеорологичните условия, както и на географското разпределение на източниците на замърсяване и техните емисии. Той дава по-прецизни резултати при практическото използване на модела, особено в по-малки по площ страни в Европа, каквато е и България.

Разработени са и метаевристични и стохастични методи за решаване на оптимизационни задачи, свързани с оптимално управление на GPS с цел повишаване на качеството на услугата; с моделиране на биореактор за производство на лекарствени субстанции с цел понижаване на цената на получените лекарства, оптимизиране на пътничкопоток при наличие на разнообразни възможности за транспорт и др.

Разработен е нов метод за автоматично търсене на оптимална архитектура на невронна мрежа за даден конкретен проблем. Това спомага за по-доброто моделиране и обработка на получената информация.

Постигнатите резултати са публикувани в 11 научни списания с импакт фактор Thomson Reuters (вариращ от 1.003 до 22.91), 13 в издания с SJR ранг на SCOPUS.

Ръководител на колектива: проф. Иван Димов.

3.2. *Най-значимо приложно постижение*

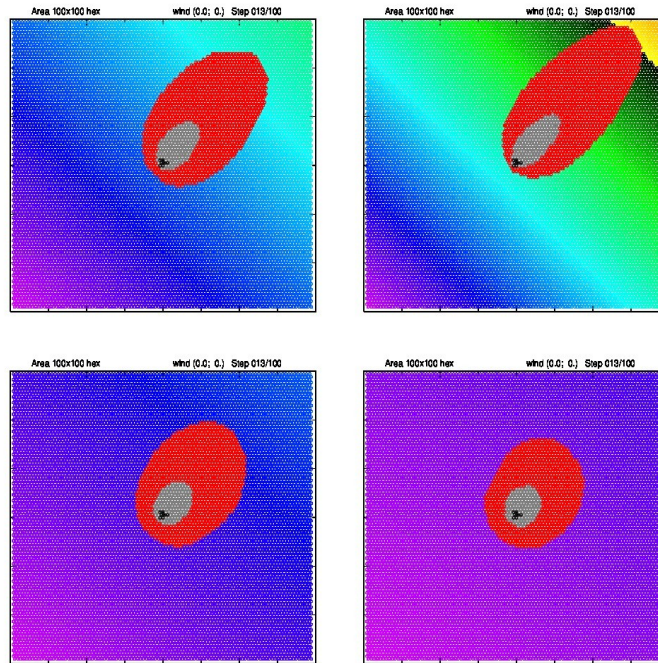
ОБРАБОТКА НА ДАННИ И МОДЕЛИРАНЕ НА ПРИРОДНИ ЯВЛЕНИЯ И ЯВЛЕНИЯ В МЕДИЦИНАТА

Разработен е модел за разпространение на горски и полски пожари с отчитане на вятър, наклон на терена и наличието на разнообразна растителност. Моделът показва фронта на пожара и неговото изменение при различни метеорологични условия и терени.

Предложен е метод за тримерно моделиране на йоносферните концентрации. С помощта на този модел могат да се проследят измененията в йоносферата предизвикани от слънчеви бури. Използваните данни са от наземни GPS станции и спътници.

Направена е обработка на данни и анализ на параметрите на кръвната плазма на различни групи пациенти. Приложен е интеркритериален и корелационен анализ на данните и са анализирани връзките между тях.

Обработени са данните от дълбочинни електроди имплантирани на две породи плъхове. Изследвани са данни от четири фази на епилептичен пристъп. Подробно е изследван спектъра на измерените сигнали. На основа на проведения анализ е направена хипотеза за това, кои изменения в спектъра са предвестници на епилептичен пристъп.



Фиг. 2. Фронт на пожара след 13 времеви стъпки при един и същи вид растителност и различна големина на наклона. С черна точка е обозначен източникът на пожара, с червено -горящата област, със сиво напълно изгорялата област. При по-голям наклон фронтът е издължен по посока на наклона, а в обратната посока е много тесен.

Постигнатите резултати са публикувани в 5 научни списания с импакт фактор Thomson Reuters (вариращ от 1.065 до 5.083), 1 в издания с SJR ранг на SCOPUS.

Участници от секцията: проф. Стефка Фиданова и доц. Пенчо Маринов

4. МЕЖДУНАРОДНО НАУЧНО СЪТРУДНИЧЕСТВО НА ЗВЕНОТО:

4.1 Организиране на международни конференции

- **Workshop on Computational Optimization 2016** – Гданск, Полша деветият „Workshop on Computational Optimization“ се проведе в рамките на FedCSIS'2016 <http://fedcsis.org/wco/>. Бяха изпратени над 35 статии, като 22 от тях бяха приети за докладване и включени в тома от конференцията. Участниците в конференцията бяха от 10 държави, както следва: Китай, Германия, Белгия, България Франция, Италия, Полша, Словакия, Тунис, Унгария. Трудовете на конференцията са достъпни в IEEE Xplore и имат импакт ранг. Разширени версии на приетите и изнесени доклади се публикуват в реномираната поредица Studies in Computational Intelligence на издателство Springer, която има SJR ранг.
- **XVII International Summer Conference on Probability and Statistics (ISCPS, 2016), 25 юни - 1 юли 2016, Поморие, <http://www.math.bas.bg/~>**

Регулярна международна конференция в областта на теорията на вероятностите и математическата статистика. На 17-тата поредна конференция участваха около 80 участници, изнесени бяха 50 научни доклада. Материалите на конференцията

(абстракти и кратки съобщения) бяха публикувани предварително в сборник. Пълните версии на избрана част от докладите са в процес на рецензиране и подготовка за публикуване в *Pliska Studia Mathematica Bulgarica*.

5. УЧАСТИЕ НА ЗВЕНТО В ПОДГОТОВКАТА НА СПЕЦИАЛИСТИ: ФОРМИ, СЪТРУДНИЧЕСТВО С УЧЕБНИ ЗАВЕДЕНИЯ, ВЪНШНИ ЗАЯВИТЕЛИ, ВКЛЮЧИТЕЛНО ОТ ЧУЖБИНА.

- 1. Стефка Фиданова, ERASMUS със Southampton Solent University
- 2. Стефка Фиданова, COST Action 1207 – делегат в управителния съвет