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Preface

The Laboratory of Process Engineering, Computer Science and Mathematics (LIPIM) organizes the third edition of the Doctoral days of Mathematics and Engineering Sciences event ("Journées doctorale en Mathématiques et Science d'Ingénieur - JDMSI'2023"). JDMSI'2023 is an opportunity for PhD students to present their innovative research work and discuss it with a community of specialists in the field.

This event brings together professors, scientists, researchers and professionals from the academic community to explore the latest advances in mathematics and engineering science. Doctoral students will have the opportunity to present their research in detail to an attentive audience, to obtain constructive feedback and to meet potential colleagues and mentors.

These days provide an opportunity to discover new ideas and approaches in the fields of mathematics and engineering science, which can stimulate future collaboration and cooperation. In short, it is a stimulating platform for doctoral students to share their passion for research and enrich their academic career.

The Topics of interest during these days include but are not limited to :

- *Applied Mathematics and Optimisation*
- *Advanced Materials Processing and Energy Systems.*
- *Computational Methods and Algorithms*
- *Data Mining and Analytics*
- *Process Design and Systems Engineering*
- *Machine Learning and Artificial Intelligence*
- *Environmental sciences , energy efficiency and renewable energy*
- *Image Processing and Computer Vision*
- *Modeling and Simulation in physical systems*
- *Computer and Data Science Applications*

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Contents

Part I

Abstracts of Plenary Talks

Numerical Methods for Physics: Monte Carlo Method and Molecular Dynamics

A. Rachadi[a]

[a]Mohamed V University, Morocco

Abstract

This talk deals with two of the main numerical methods used in condensed matter physics: Monte Carlo and Molecular Dynamics. The implementation of these methods is especially applied to study the physical properties of materials. They generally use as input, the results of prior quantum ab -initio simulations such as density functional theory (DFT). From one hand, Monte Carlo (MC) method is stochastic in nature and can efficiently be used to determine magnetic properties of a material such as specific heat, transition temperature from ordered to disordered state, etc .... MC can be implemented using either Metropolis single flip or cluster updating. From the other hand, Molecular Dynamics (MD) is a deterministic method based on the integration of the equations of motion. It is especially used to study structural as well as transport properties of materials. The two methods have the advantage of a range of validity beyond zero temperature.

Est-ce qu'une vérité mathématique est forcément démontrable ?

H.Ifzarne[a]

[a]Sultan Moulay Sliman University, Morocco

Résumé

En 1931, le mathématicien Kurt Gödel a publié son fameux théorème d'incomplétude qui prouve que quoi qu'on fasse, il existe des énoncés mathématiques vrais, mais indémontrables. Ce résultat a marqué un tournant dans l'histoire de la logique et des mathématiques. Voilà certaines questions qu'on discutera autour de ce sujet :

— Peut-on tout démontrer en mathématiques ?
— Qu'est-ce qu'une proposition indécidable ?
— Est-ce possible de construire un système d'axiomes parfait (cohérent et complet) ?
— Est-ce possible de montrer la cohérence d'une théorie axiomatique (l'arithmétique par exemple) ?
— Est-ce que ces problèmes classiques sont indécidables : hypothèse du continu, axiome du choix, lemme de Zorn, problème de l'arrêt ?
— Qu'est-ce qu'une vérité mathématique ?

Machine learning: Mathematical Background, challenges and some applications

Mourad NACHAOUI*

EMI, Sultan Moulay Slimane, Bni-Mellal Morocco

Abstract

Artificial intelligence is becoming more and more embedded in our modern life. Machine learning, as it plays a driving role in the field of AI, is probably becoming the most sought-after profile in engineering without forgetting scientific research. Nevertheless, although everyone talks about it, few users who really know how it works and their mathematical background, even less for their challenges. In this presentation we will explain the mathematical background of machine learning, their challenges and some applications.

keywords: Artificial Intelligence, Machine Learning, Optimization.

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*Corresponding author :m.nachaoui@usms.ma

A theoretical approach for the study of the physical properties of 2D and 3D materials.

H. Zaari[a]

[a]Mohamed V University, Morocco

Résumé

Lors des dernières décennies, l'accroissement de la puissance informatique disponible ainsi que le développement d'algorithmes de plus en plus performants ont contribué à l'évolution des techniques de modélisation des matériaux à l'échelle atomique. Il est actuellement possible de caractériser fidèlement les propriétés de nombreux matériaux en appliquant des méthodes basées sur les lois fondamentales de la mécanique quantique. Même si l'étude pratique des systèmes complexes nécessite quelques approximations, les résultats ne dépendent d'aucun paramètre empirique ajustable. C'est la raison pour laquelle ces techniques sont communément appelées calculs ab-initio, ces méthodes ont été largement appliquées à l'étude des matériaux et ont contribué à améliorer notre compréhension de l'origine microscopique de leurs propriétés. Nous allons discuter comment extraire les propriétés optiques et magnéto-optiques des matériaux semi-conducteurs pour différentes structures. Les calculs se base sur la théorie de la densité fonctionnelle (DFT) ou on calcul la densité électronique à partir de la résolution des équations de schrodinguer afin de remonter aux différentes critères qui répondent à chaque application : spintronique , magnetocalorie, photocatalyse ..

Part II

Computer Science and Applications

Application of neural machine translation for Moroccan Arabic Dialect

BOURHAZZAL ABDELMAJID *[a], HAFIDI IMAD[a], and ELASBAHANI ABDELTEF[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

This is an overview on the application of Neural Machine Translation (NMT) for translating from the Moroccan Arabic Dialect (MAD) to Standard Classic Arabic (SCA). We aimed to investigate the effectiveness of using NMT for this specific translation task, which is challenging due to the significant linguistic and cultural differences between the two language varieties.

keywords: NMT, MAD, SCA, translation task, Neural Machine.

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*Corresponding author :majid.bourhazal@gmail.com

State of The Art in Neural Network Compression

Abdelfattah TOULAOUI*[a], Imad HAFIDI[a], and Hamza KHALFI[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

Deep Learning is one of the most powerful machine learning tools available across a variety of tasks including medical imagery, autonomous vehicles, speech recognition, and natural language instruction following. However, the size and complexity of the models have increased exponentially over the past few years to where they require specialized hardware to run efficiently, which makes them costly and sometimes impracticle to deploy in real-world scenarios. We present the state-of-the-art approaches that have been proposed to compress deep learning models and reduce the number of weights and the amount of computations needed at runtime.

keywords: Deep Learning, Neural Networks, Pruning, Compression

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*abdelfattah.toulaoui1@usms.ac.ma

Process and Data quality on big data Architecture

Abdelghafour BENOUALY *[a], Imad Hadifi[a], and Nassima Soussi[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

Improving data quality can be a challenging task, but it is crucial for making informed decisions and ensuring the accuracy of analysis. Also having the right decision-making by the business for any reporting or analytics demand relies on certain data quality requirements that must be ensured throughout the data life cycle. In this paper, we present different approaches and process to manage and control the governance of the data quality. In this related work, we also share some data process tools in the classical ETL and data warehouse concept that demonstrate the use of the some commercial tools. In our study, we will present the use of a powerful tool with a new architecture based on different types and sources of data (internal and external)

keywords: Big Data, architecture, Data Quality, Open Data, Data Warehouse, Architecture

*abdelbenoualy@gmail.com

VARIATIONAL ANALYSIS OF A DYNAMIC CONTACT PROBLEM IN THERMO-ELECTROVISCOELASTICITY

OUAANABI Abdelhafid *[a], ALAOUI Mohammed [a], ESSOUFI El-Hassan[a], and BOUALLALA Mustapha[a,b]

[a]Univ. Hassan 1, Laboratory MISI, 26000 Settat, Morocco.
[b]Department of Mathematics and Computer Science, Polydisciplinary faculty of Safi, Cadi Ayyad University, Marrakech, Morocco.

Abstract

We consider a mathematical model which describes the dynamic process of contact between a piezoelectric body and a rigid foundation. We model the materials behavior with a thermo-electroviscoelastic constitutive law. The friction is modeled with Trescas friction law. We derive variational formulation for the model which is in the form of a system involving the displacement field, the electric potential and the temperature. We prove the existence of a unique weak solution to the problem. The proof is based on regularization method followed by Faedo-Galerkins method and fixed point theorem.

keywords: Thermopiezoelectric;Weak solvability; Regularization method; Faedo-Galerkin method; Banach fixed point theorem.

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*Corresponding author: ouaanabi@gmail.com

Sentiment Analysis in Moroccan Dialect "Darija" Using Transformers: A comparative study

Amnay Meriem *[a] and Hafidi Imad †[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

NLP is a part of Artificial Intelligence that helps computers understand, interpret and create human language in different languages, including Arabic. One of the important tasks of NLP is sentiment analysis, which involves identifying the emotions expressed in a text. This task has attracted the attention of many people in the MENA region. However, sentiment analysis in Arabic is very complex due to its morphology and dialects. To solve this problem, researchers are developing NLP methods specifically for Arabic and creating annotated corpora for machine learning. In this article, we have conducted a study on different methods and models based on the Transformer architecture, such as BERT, for Arabic languages, specifically the Moroccan dialect "Darija". We suggest using pre-trained Arabic BERT models for various Arabic machine learning tasks with transfer learning models. We fine-tuned the parameters of these models on our dataset to help analyze sentiment in Arabic texts.

keywords: NLP, Sentiment Analysis, Transformers, Bert, MENA, Bert in Arabic, Darija, fine-tuning.

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*Corresponding author: amnay.meriem@gmail.com
†: i.hafidi@usms.ma

Machine Learning and Deep Learning for Health Informatics

chaimae TAOUSSI *[a], Imad HAFIDI[a], and Abdelmoutalib METRANE [a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

Medical or health informatics is a growing field that involves the application of computing, technology, and information in public health to optimize the storage and use of information in biomedicine. Recently, big data has become commonplace in healthcare due to the large amount of data available, the increase in healthcare spending, and the need for individualized care. Machine learning (ML), as well as deep learning, have become crucial for researchers in the field of medical informatics, as they have enabled better decision-making, such as diagnosis, prediction, and clinical data mining. After conducting a recent detailed systematic review, our paper explores four key topics related to machine learning and deep learning in health informatics: improved medical diagnosis, disease prediction, improved medical care, ehealth management, and accurate and timely prediction of medical conditions. Limitations and restrictions of the use of these techniques are also discussed.

keywords: health informatics, machine learning, deep learning, big data, technology, pathologies prediction.

*Corresponding author :chaimae.taoussi@usms.ac.ma

Generalized Translation and Convolution associated to the Linear Canonical Fourier-Jacobi Transform

Abdellatif AKHLIDJ*[a], Afaf DAHANI[a], and Fatima ELGADIRI[a]

[a]Faculty of Sciences Ain Chock Casablanca, University Hassan2

Abstract

In this paper, we introduce the Canonical Fourier-Jacobi transform, define a translation operator and we also derive a convolution product related to this transform. Some important properties are established.

keywords: Canonical Fourier-Jacobi transform, translation operator, convolution product.

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*elgadiri.fatima@gmail.com

Machine learning at the service of algorithm selection problem

Hajar BOUALAMIA *[a], Abdelmoutalib METRANE [a], and Imad HAFIDI[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

In the literature, numerous investigations have been undertaken to construct high-performance metaheuristics (MHs) for well-known Combinatorial Optimization Problems (COPs). However, no single MH outperforms all others in solving every instance of a problem. Instead, different MHs have been shown to perform well on different instances. As a result, the subject of finding the appropriate algorithm for a given COP remains unanswered. In theory, running all available algorithms exhaustively and selecting the best answer would be the ideal technique, but it is practically difficult due to restricted computer resources. As a result, the difficulty is to choose the best algorithm(s) from among those already available for a specific problem instance. Machine Learning (ML) approaches can help solve this problem by picking the best algorithm(s).

keywords: Combinatorial Optimization Problems, Metaheuristics, Machine Learning.

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*Corresponding author :hajar.boualamia33@gmail.com

Integrating Fog Computing in WSN for Attack Detection

Hiba Tabbaa *[a] and Imad HAFIDI †[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

Wireless sensor networks (WSN) have been a significant area of research in the past century due to their promising technology, and they are now considered the foundation of the Internet of Things paradigm. However, WSNs are vulnerable to security breaches due to the lack of a physical line of defense, making network security a major concern, especially in applications where confidentiality is critical. In order to ensure secure WSNs, it is necessary to detect any intrusion before attackers can cause harm. However, current approaches to identifying attacks are ineffective, particularly in realtime, due to the accumulation of vast amounts of data from interconnected devices. Therefore, this paper proposes a framework for detecting anomalies in real-time by developing and implementing a data analytic system capable of processing large amounts of data while maintaining high performance, such as predictive accuracy.

keywords: Wireless Sensor Networks, Fog Computing, Streaming Data, Intrusion Detection System, Machine Learning.

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*Corresponding author :hibatabbaa@usms.ac.ma
†:i.hafidi@usms.ma

Arabic Speech Recognition

Hind AIT MAIT*[a] and Noureddine Aboutabit[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

Automatic speech recognition (ASR) has become a crucial technology in many applications, including mobile voice application, hearing aids for handicap, language learning. Arabic is one of the most widely spoken languages in the world and it is a complex language with many dialects and variations which presents significant challenges for ASR systems. The goal of our thesis is to elaborate an Arabic ASR which consists of important phases among them: the detection of the speech regions as known: Voice Activity Detection (VAD), we have already carried out this phase obtaining an accuracy of 90.79segmentation, whose objective is separating the input speech signal into fundamental units: words, syllables, or phonemes. There are two categories of speech segmentation algorithms that have been studied in the literature: unsupervised (implicit) and supervised (explicit) methods. For the moment, we are realising an Arabic unsupervised speech segmentation method based on the spectral contrast to detect the boundaries of syllables units.

keywords: Arabic Sign Language Database, Sign Language Recognition, 3D Convolutional Neural Network

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*hind.ait-mait@usms.ac.ma

Unsupervising Denoising Model Based Generative Adversarial Network

H.Hafsi[a], A.Ghazdali[a], and H.Khalfi[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

This paper addresses a novel method, based on generative adversarial network (GAN) for denoising images especially in an unsupervised setting from corrupted and unpaired datasets of images. The only source of information is offered by the observations and the measurement process statistics. The process aims to find the maximum a posteriori (MAP) estimate of the distribution given each measurement, optimizing the noise generating distribution represented analytically defined noise as the likelihood and the GAN as the prior. In which the generator takes a corrupted observation as input to generate realistic reconstructions, and then adds a penalty term tying the reconstruction to the related observation. We test our approach on a variety of common datasets with varied sizes and levels of corruption. The proposed method offers an alternative to unsupervised denoising and achieves results that are comparable to the state-of-the-art in generative models noise removal.

keywords: Generative adversarial networks, Denoising image, Inverse problems, Unsupervided learning.

Fuzzy Asynchronously hybrid particle swarm optimization algorithm for text feature selection problems

Issam Lakouam *[a], HAFIDI Imad †[a], and Mourad Nachaoui ‡[b]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university
[b]Laboratory of Mathematics and Applications, Team of Mathematics and Interactions,
Faculty of Science and Technology,, Sultan moulay slimane university

Abstract

Metaheuristic algorithms are the most widely used technique for improving feature selection methods, particularly the Particle Swarm Optimization (PSO) algorithm, due to its ease of implementation and potential global research capacity. The performance of PSO, like that of many other optimization algorithms, is highly dependent on the appropriate setting of its parameters (i.e., inertia, cognitive and social factors). Recently, several studies have attempted to use fuzzy logic to improve the performance of the particle swarm optimization (PSO) method. This paper proposes a new self-tuning hybrid particle swarm optimization algorithm called Fuzzy Asynchronously Hybride PSO (FAHPSO), which uses two different fuzzy logics Asynchronously to calculate the inertia weight w and the learning factors c1 and c2 parameters independently in each generation. The proposed method is compared to the Hybrid PSO (HPSO), Fuzzy Incremental PSO (FIPSO), Fuzzy Global PSO (FGPSO), and Genetic Algorithm (GA) to assess its performance. The experiment is carried out on two reference text datasets, Reuters21578 and WebKB. According to the results, the proposed approach FHPSO outperformed the competitor methods regarding precision, recall, F-measure, and clustering accuracy.

keywords: Unsupervised Feature Selection, Fuzzy Logic, Particle Swarm Optimization, Self-Tuning, Algorithms, Text Mining.

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*Corresponding author :issam.lakouam@usms.ac.ma
†:i.hafidi@usms.ma
‡:m.nachaoui@usms.ma

Emotion Recognition Based on Deep Learning Techniques

KNOUZI Maryam*[a], ENNAJI Fatima zohra[a], and HAFIDI Imad[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

In this paper, methods for obtaining facial images from convolutional neural networks in order to recognize emotional expressions are evaluated. The primary goal of the paper is to explore the most popular techniques for analyzing and identifying facial expressions of emotion. Traditional techniques and those particularly created using neural networks can be identified as the two primary tendencies of the reviewed works. The following section of this paper covers the challenges encountered when analyzing the database images used, notably FER2013. The analysis revealed that using CNNs improved level of performance

keywords: Emotional expressions, CNNs

*maryamknouzi@gmail.com

Heuristic algorithms for extracting frequent itemsets mining in massive datasets

BARIK Meryem *[a], HAFIDI Imad †[a], and ROCHD Yassir ‡[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

Frequent Itemsets Mining (FIM) is a well-known problem in data mining that involves to find sets of items that frequently appeared in large datasets. Solving the FIM problem aims to identify all the subsets items that occur frequently across transactional datasets with a support threshold specified by the user. There are two categories of approaches that solve the FIM problem: Exact and metaheuristic-based approaches. Exact approaches, such as the Apriori algorithm, are particularly successful in dealing with small to medium datasets. These approaches suffer from temporal complexity when dealing with large datasets. Although metaheuristic-based approaches are improving, most of them remain poorly precise. Different research has been carried out to enhance metaheuristics-based techniques by merging the recursive property of the Apriori algorithm with several metaheuristics algorithms such as Genetic Algorithm (GA) and Particle Swarm Optimization (PSO) to address these challenges. As a result of this combination, two techniques emerged: GA-Apriori and PSO-Apriori. As a consequence, after multiple investigations on various database cases, the results demonstrated that the two techniques surpass the Apriori algorithm in terms of runtime, and the PSO-Aprioi outperforms the GA-Apriori in term of solution efficiency.

keywords: Frequent Itemset Mining (FIM), Metaheuristic, Apriori, Genetic algorithm (GA), Particle Swarm Oprimization (PSO).

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*Corresponding author :meryem.barik@usms.ac.ma
†:i.hafidi@usms.ma
‡:y.rochd@usms.ma

Trading strategy optimization with ARIMA and LSTM

Oukhouya Mohamed Hassan *[a], Aboutabit Noureddine[a], and Hafidi Imad[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

This article explores the application of ARIMA and LSTM in predicting stock prices and implementing trading strategies. The ARIMA model uses historical data to forecast future prices, while the LSTM model utilizes recurrent neural networks to capture long-term dependencies in the data. By combining these models, traders can create more accurate predictions and make informed decisions about buying and selling stocks. The article outlines the steps involved in implementing an ARIMA and LSTM-based trading strategy, including data preprocessing, model training and evaluation, and strategy optimization. Additionally, it examines the benefits and limitations of each model and provides guidance on how to choose the best model for a given trading scenario. Finally, the article presents a case study of an ARIMA and LSTM-based trading strategy that demonstrates how these models can be used to optimize trading decisions and increase profitability. Overall, this article provides traders with valuable insights into the potential of ARIMA and LSTM models for enhancing trading strategies and achieving better financial outcomes.

keywords: Trading, strategy, machine learning, ARIMA, LSTM.

*Corresponding author :oukhouya.mhassan@gmail.com

Sentiment Analysis and Emotion Classification in Moroccan Dialect

Jbel Mouad *[a], HAFIDI Imad [a], and Metrane Abdelmoutalib[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

This research work focuses on improving the accuracy and reliability of sentiment analysis and emotion classification in Moroccan dialect, which is a widely spoken Arabic dialect in Morocco. To achieve this goal, the research includes several stages, such as studying sentiment analyses in Moroccan dialect in the web, creating a sentiment analyses dataset for Moroccan dialect from social media, developing tools to detect the language of Moroccan dialect among other languages, enhancing the precision of sentiment analyses, using deep learning and ensemble learning to improve the precision, and studying emotion classification in Moroccan dialect using data augmentation. The research employs various techniques from natural language processing, machine learning, and deep learning, and involves experiments and evaluations on real-world data samples. Our results indicate that the proposed methods have achieved promising performance in both sentiment analysis and emotion classification. Specifically, the deep learning-based approach for sentiment analysis has achieved an accuracy of 91%, while the emotion classification using data augmentation has achieved an accuracy of 77%. The research contributes to the development of natural language processing tools and resources for under-resourced languages and dialects, and can have multiple applications in social media monitoring, customer feedback analysis, and cultural and linguistic studies. By focusing on Moroccan dialect, this research sheds light on the linguistic and cultural diversity of the Arab world, and demonstrates the potential of NLP techniques for capturing and analyzing language in diverse contexts.

keywords: NLP, Moroccan dialect, Depp Learning, Machine learning

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*Corresponding author :mouad.jbel@gmail.com

Facial Recognitin using Machine Learning

Otmane ED-DAROUICHa*[a], Nidal LAMGHARI[a], and Abdelghani GHAZDALI[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

Nowadays, there are Artificial Intelligence algorithms capable of performing human-made tasks, about this we find in particular facial recognition, which is an important function of systems and especially in monitoring, biometrics, robotics, precess over 99%. The days of the pandemic were exceptional in all respects due to the different economic and political conditions. Morocco, like other countries, has taken many precautions to mitigate the losses emanating from the pandemic. Masks were worn to prevent the spread. More than 50% of the face has been masked and this makes it difficult on the one hand to identify in general and on the other hand facial recognition becomes difficult because of the mask. To maintain global insurance, systems are needed to detect whether citizens are wearing masks. In order to facilitate general control on the one hand and compliance with the rules in force, which in particular require the wearing of masks, on the other. This work concerns a study concerning the field of machine learning. It is first a question of making a general study in this field, then making a bibliographical study of the existing systems and the various research carried out on facial recognition and the Convolutional Neural Network (CNN) model and tools like TensorFlow, OpenCV from machine learning. Please do not use any symbols, special characters, footnotes or math in the title or abstract of the document.

keywords: facial recognition, mask, machine learning, Convolutional Neural Network (CNN), TensorFlow, OpenCV, Artificial Intelligence

*otmane.eddarouich@usms.ac.ma

Quadruplet loss-based masked face recognition

S.Ahmam *[a], N.Lamghari[a], A.Ghazdali[a], and H.Khalf[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

Masked face recognition is a significant difficulty due to the lack of facial features. Masks hide crucial facial features that are employed in face recognition systems, challenging this identification form. In this paper, we present a deep learning-based model for identifying masked faces. We base on an input of quadruplets set from three different people. Two images from the same person and two others from two different people. We use a neural network called FaceMaskNet-21 with some changes in the architecture of the model to generate the encoding of the input images. Then, we classify these images by calculating the distance between the extracted encodings using the Euclidean distance as a metric. We experimentally study the variations of our model by substituting the Euclidean distance with the Manhattan distance or a neural network with binary classification. We train our model on a dataset of almost 32K images of masked faces properly collected from students of our university. Finally, we discuss the results obtained on our own dataset and those obtained during the test of our model on COMASK20 dataset.

keywords: Face recognition, Face mask, Quadruplet loss, Deep metric learning, Neural network.

*Corresponding author :siham.ahmam@usms.ac.ma

Feature Selection for Text Classification Using Genetic Algorithm

Salma Belkarkor *[a], HAFIDI Imad †[a], and Mourad Nachaoui ‡[b]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university
[b]Laboratory of Mathematics and Applications, Team of Mathematics and Interactions,
Faculty of Science and Technology,, Sultan moulay slimane university

Abstract

Today's large amount of text data makes feature classification difficult to process. High dimensionality is the primary challenge in text processing, and feature selection is a common method for reducing dimensions. The most crucial factors in text classification are a strong text representation and a very accurate classifier. As a result, choosing the right features is essential for using machine learning algorithms effectively. Different optimization techniques, including the Genetic Algorithm (GA), have been effectively used for dimensionality reduction in text classification. To evaluate the performance of GA for Feature Selection (FS), we compared the GA for FS with other filtering methods to prove the efficiency of the GA for FS, for that, we used the NB classifier and three benchmark document collections: SMS, BBC, and 20Newsgroups.

keywords: Feature selection, Text classification, Genetic Algorithm.

*Corresponding author :salma.belkarkour@usms.ac.ma
†:i.hafidi@usms.ma
‡:m.nachaoui@usms.ma

Parkinson's Disease Early Diagnosis based on a new feature selection technique for non-smooth SVM

Z.KHOUDI*[a], M.NACHAOUI[a], and S.LYAQINI[b]

[a]EMI, FST Sultan Moulay Slimane University Beni Mellal Morocco
[b]Ecole Nationale des Sciences Appliquees, LAMSAD Laboratory Hassan First University Settat Morocco

Abstract

Parkinson's disease (PD) most often affects persons over 50 and millions globally. Despite several technical and medical improvements, detecting PD in its early stages remains difficult. Therefore, automatic methods based on machine learning are required to support healthcare professionals in accurate and timely disease detection. In this work, we suggest a machine learning approach to forecast Parkinson's illness. In order to decrease the number of needed input characteristics, we specifically offer a unique feature selection strategy that uses the variance inflation factor (VIF), the most used indicator for identifying multicollinearity. We also contrast the outcomes of our strategy with those of conventional machine learning methods. The findings show that our method can provide a high prediction geometric mean (Gmean) of around 97% while using fewer features. This research may have helpful therapeutic applications and be a resource for doctors.

keywords: Healthcare, Machine learning, Non-smooth SVM, Parkinson's Disease prediction

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*zakaria.khoudi@usms.ma

A 3D CNN-Based Approach for Arabic Sign Language Recognition

Ihssane Bouhanou*[a] and Noureddine Aboutabit[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

Arabic Sign Language (ArSL) is a natural sign language used by deaf communities in Arab countries. Recognizing ArSL is a challenging task due to its dynamic and complex nature of sign languages. In recent years, the use of deep learning techniques for ArSL recognition has shown promising results. Specifically, 3D convolutional neural networks (CNNs) have been proposed as a powerful tool for modelling the spatiotemporal dynamics of sign language gestures [2]. In this paper, we introduce our first approach using KArSL database for ArSL consisting of 502 signs [1]. Signs in KArSL database are performed by three professionals. We will evaluate our proposed method on the large-scale KArSL dataset and report promising results.

keywords: Arabic Sign Language Database, Sign Language Recognition, 3D Convolutional Neural Network

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*bouhanouihssane@gmail.com

Entity Resolution

JABRANE Mourad *[a], HAFIDI Imad †[a], and ROCHD Yassir ‡[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics
National school of applied sciences , Sultan moulay slimane university

Abstract

Entity resolution, also known as record linkage or data matching, is the process of identifying and merging records that refer to the same real-world entity. This task is crucial in many applications, including customer relationship management, fraud detection, and healthcare. Traditional entity resolution methods often rely on rule-based or probabilistic algorithms that are tuned to specific domains and require manual tuning. Machine learning and deep learning methods offer promising approaches for improving its accuracy and automation. Both methods have shown success in several studies, but also present some challenges. In the context of machine learning in real-world applications, one of the primary challenges is the laborious and costly process of annotating training data. Another significant obstacle is the incompatibility of deep learning techniques with the handling of the vast and heterogeneous information contained in the semantic web's linked data. The linked data exhibits characteristics such as a high degree of diversity, incompleteness, and semi-structure, rendering traditional deep learning approaches unsuitable for processing such information.

keywords: Entity resolution, Machine Learning, Deep Learning, Semantic web data.

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*Corresponding author :jabrane.mourad@usms.ac.ma
†:i.hafidi@usms.ma
‡:y.rochd@usms.ma

Deep Learning-Based Approach for Mammography Image Analysis in Breast Cancer Detection: A Promising Paradigm

Youssef LAHDOUDI*[a], Abdelghani GHAZDALI [a], Nidal LAMGHARI[a], and Hamza KHALFI[a]

[a]LIPIM, ENSA Khouribga, université sultan moulay slimane, Morocco

Abstract

Breast cancer is a significant public health challenge in Morocco, characterized by high incidence and mortality rates, making it the second leading cause of cancer-related deaths among women. Early detection plays a crucial role in reducing mortality rates, and mammography is widely recognized as an effective screening method for diagnosing breast cancer. However, inconclusive or abnormal mammogram results often necessitate further investigation through biopsy. This study aims to develop a reliable tool for accurate and efficient classification of breast cancer at an early stage using mammography images. To achieve this objective, Deep Learning (DL), a branch of artificial intelligence derived from Machine Learning, was employed. DL models draw inspiration from the complex structure and functioning of the human brain. Leveraging powerful computing capabilities, vast amounts of data, and intelligent algorithms, deep learning has gained significant attention in radiology over the past decade. Its potential for high performance in various tasks such as detection, classification, segmentation, monitoring, and prediction has been widely acknowledged. In this study, we propose a Deep Learning-based approach for predicting breast cancer. The approach incorporates different models, including the Convolutional Neural Network (CNN) and pretrained models ResNet-50, DenseNet-121, and InceptionNetV3. Extensive testing was conducted to evaluate the performance of each model and compare the quantitative results. The test data were sourced from Mohammed VI Hospital and verified by radiologists. The obtained results are promising, with reported accuracy rates as follows: ResNet-50 (84.44% accuracy), DenseNet-121 (79.44% accuracy), and InceptionNetV3 (90.55% accuracy). These findings demonstrate the potential of Deep Learning in achieving accurate and efficient early detection of breast cancer using mammography images.

keywords: Breast cancer, Mammography, Deep Learning, Convolutional Neural Networks, Image analysis, Early detection, Diagnostic accuracy, Medical imaging.

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*Corresponding author :youssef.lahdoudi@usms.ac.ma

Part III

Engineering Science and Industrial Process

Effect of pressure on the optical and thermoelectric properties of the perovskite compound BaSiO3: Ab initio calculations

A. Ou-khouya[a], I. Ait Brahim[b], M. Tahiria[a], A. Houba[c], H. Mes-addi[a], and R. Errahel[a]

[a]LIPIM Laboratory, ENSA-Khouribga, Sultan Moulay Slimane University of Beni Mellal, B.P. 77, 25000 Khouribga, Morocco

[b]LCMIS Laboratory, Faculty of Sciences, Mohammed V University, B.P. 1014, 10090 rabat, Morocco

[c]LS2ME Laboratory, Polydisciplinary Faculty of Khouribga, Sultan Moulay Slimane University of Beni Mellal, B.P. 145, 25000 Khouribga, Morocco.

Abstract

In this work, the impact of pressure on the optical and thermoelectric properties of BaSiO3 is studied using density functional theory (DFT) within the Wien2K code. The mechanical stability of the material is confirmed by calculating the Poisson and Pugh ratios. It is observed that the band gap of BaSiO3 changes from indirect to direct when subjected to a moderate pressure of 15 GPa, thereby eliminating the effects of phonon heating during optical transitions. Optical parameters including dielectric constants, absorption coefficient, optical conductivity, and reflectivity are discussed in the energy range 0-30 eV. In addition, the electrical and thermal conductivities, power factors, and other related factors depend of pressure within a temperature range of 0 to 800 K. Based on the optical and thermoelectric properties of BaSiO3 we show that has a potential for use in renewable energy devices applications.

Nanoparticle size effect on thermal conductivity of Cuwater nanofluid using molecular dynamics simulations

A. Toulil[a], A. Hasnaoui[a], and Mly. M. Charafi[a]

[a]LS2ME, Polydisciplinary Faculty of Khouribga, Sultan Moulay Slimane University of Beni Mellal, 25000 Khouribga, Morocco ABSTRACT

Abstract

Nanofluids are mixtures of two components, a base liquid and solid particles with a volume fraction typically smaller than 100 nm. The improvements in heat transfer in nanofluids have made them attractive and have been the subject of many theoretical and experimental studies. A molecular dynamics (MD) simulation approach was used to investigate the effect of the nanoparticles size on the thermal conductivity of Cu-water nanofluid. The thermal conductivities of nanofluids are predicted by using the Green-Kubo method. The SPC/E model, in which both hydrogen and oxygen atoms are considered rigid particles, was used. The volume fraction for the copper nanoparticles with different diameters is the same ($\rho = 1.5\%$). The result indicate that the thermal conductivity increases with an increase in the nanoparticle diameters.

keywords: Nanofluids, Thermal enhancement, Molecular dynamics

Impact of Pressure on Local Structure and Mechanical Properties of Monatomic Metallic Glass

A. Houba *[a], M. Ayoubi[a], A. Ou-Khouya[b], A. Hassani[a], and A. Hasnaoui[a]

[a]LS2ME Laboratory, Polydisciplinary Faculty of Khouribga, Sultan Moulay Slimane University of Beni Mellal, B.P. 145, 25000 Khouribga, Morocco.
[b]LIPIM Laboratory, ENSA-Khouribga, Sultan Moulay Slimane University of Beni Mellal, B.P. 77, 25000 Khouribga, Morocco. Corresponding author:

Abstract

In this study, the impact of pressure on the local structures and mechanical properties of pure Tantalum metallic glasses was investigated through molecular dynamics simulations. The obtained results demonstrate that glassy states are achieved at or below 20 GPa at a quenching rate of 1 × 1013 K/s, while crystalline phases are attained at 25 GPa. The Voronoi analysis revealed that the local structure of glassy Tantalum alters with the increase in pressure, leading to a reduction in the degree of local fivefold symmetry in the quenched systems. Furthermore, the tensile test outcomes demonstrate a negative correlation between pressure and the yield strength, as the strength of the glass obtained at 20 GPa is 7obtained at 0 GPa. This investigation provides insights into the effects of pressure on the local structure and mechanical properties of monatomic metallic glasses.

keywords: Metallic glass, High pressure, Structure

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*Corresponding author :adilmonir393@gmail.com

Dessalement des eaux par formation décomposition d'un hydrate de propane

A. RABHI *[a], S. TOUIL[a], and A. ABID[b]

[a]Laboratoire d'Ingénierie des Procédés, Informatique et Mathématique (LIPIM). Ecole Nationale des Sciences Appliquées de khouribga, Université Sultan Moulay Slimane, Maroc
[b]Laboratoire des Sciences et Techniques pour l'Ingénieur (LaSTI). Ecole Nationale des Sciences Appliquées de khouribga, Université Sultan Moulay Slimane, Maroc

Abstract

Le dessalement de l'eau est devenu une nécessité dans de nombreuses régions du monde en raison de la rareté croissante des ressources en eau douce. La formation-décomposition des hydrates de propane est une méthode prometteuse pour produire l'eau douce à partir d'eau salée. Dans ce travail, nous explorerons le principe de fonctionnement et les avantages de cette méthode pour le dessalement de l'eau. Les hydrates de gaz sont des composés cristallins, non stœchiométriques, formés à partir de molécules d'eau disposées en cages, pouvant contenir des molécules de gaz. Le choix du propane en tant qu'hydrocarbure léger est fondé sur la formation d'une structure d'hydrates de type II, incorporant 136 molécules d'eau. Cette technique de dessalement des eaux nécessite des réacteurs pour former puis décomposer les hydrates de propane. Pour ce faire, du propane est barboté dans l'eau salée, et les cristaux d'hydrates de propane se forment par germination dans des conditions de pression et de température spécifiques. L'étape qui suive est le lavage pour éliminer la couche du sel entourant les cristaux. Enfin, la décomposition pour obtenir de l'eau douce et le gaz propane qui peut être recycler. La méthode de dessalement par formation-décomposition des hydrates de propane s'avère économique en termes d'énergie, car la production d'un mètre cube d'eau douce ne nécessite que 10 kW, tandis que la distillation en exige cinq fois plus.

keywords: dessalement, eau salée, hydrates de propane, cristaux d'hydrates.

*Corresponding author :medrabhi97@gmail.com

Particle size effect on the efficient of recovery of andalusite Minerals in the gravity concentration process

Charaf Elhani *[a], Kamal Tabit[a], and Kaoutar Khallaki[a]

[a]LIPIM Laboratory, National School of Applied Sciences of Khouribga, Sultan Moulay Slimane University, Khouribga, Morocco

Abstract

As an ecofriendly method, the gravity separation process is a key technology in the recovery of a range of mineral ores including andalusite minerals. This Present paper studies optimisation of concentration a lowgrade andalusite ore using shaking table method. In order to concentration, 6 factors were considered: particle size, water flow rate, frequency, liberation range, tilt angle and feed rate. Optimization was carried out by classic method (one factor at the time) to predict the effect of changes in particles sises ore characteristics on shaking table performance by measuring quantitatively the mineralogy of the concentrate obtained. As a result, optimum condition obtained under particle size of +0.15 -0.35 mm, water flow rate of 10.40 lit/min, frequency of 340 cycles/min, deck tilt angle of 11.73 degrees and feed rate of 150 g/min. This test yielded 80% of Al2O3 recovery under optimum conditions performance, and a concentrate with 38.46% Al2O3 was produced.

keywords: andalusite, gravity separation, shaking table, particle size

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*Corresponding author :elhani.charaf@gmail.com

A review on granulation process in the phosphate fertilizer production: Experiment studies and modelling by CFD approach

Fatima Ezzahra BAALI *[a] and Lhachmi KHAMAR[a]

[a]Laboratory of Process Engineering,Computer Science and Mathematics, National School of Applied Sciences, Khouribga, Morocco

Abstract

The identification of hydrodynamic flow regimes and determination of behaviors are the important tasks in the design and scale-up of fertilizer granulation processes. This work reviews most hydrodynamic studies performed for flow regime identification in Drum granulator reactors. It begins with a brief introduction to the granulation process in phosphate fertilizer industries. The second section examines both various flow regimes and experimental methods for measurement of flow regime transition. A few experimental studies are presented in detail, followed by the effect of operating and design conditions on flow regime transition. A table summarizes the reported experimental studies, along with their operating and design conditions and significant conclusions. The next section deals with the current state of transition prediction, and includes purely empirical correlations, semi-empirical models, linear stability theory, and Computational Fluid Dynamics (CFD) based studies.

keywords: Granulation, Rotary drum, CFD approach, Phosphate, Fertilizers, Modelling, hydrodynamic.

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*Corresponding author :fatima.ezzahra.baali@gmail.com

Numerical simulation for viscoelastic fluid flow

Nassiri Fatima Ezzahra *[a] and Bouidi Abderrahim[a]

[a]Laboratory of Engineering science, Ibn Zohr University-AGADIR

Abstract

Complex fluids exist in nature and are continually engineered for specific applications involving the addition of macromolecules to a solvent, among other means. This imparts viscoelasticity to the fluid, a property responsible for various flow instabilities and major modifications to the fluid dynamics. In this work we review recent developments of stabilization approaches to cope with the High Weissenberg Number Problem (HWNP).

keywords: Stabilization approaches, Oldroyd-B, High Weissenberg Number Problem.

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*Corresponding author :fatimaezzahra.nassiri@edu.uiz.ac.ma

Study surface roughness under temperature and deposition rate effect during the homoepitaxial growth of Ag on Ag(100) substrate using Kinetic Monte Carlo simulation

Hassan Ataalite *[a], Moloudi Dardouri[a], Ahmed Fathi[a], Abdellatif Hasnaoui[a], and Khalid Sbiaai †[a]

[a]Laboratoire de Sciences des matériaux, des Mathématiques et Environnement (LS2ME), Facultée polydisciplinaire de Khouribga, Universitée Sultan Moulay Slimane, Maroc

Abstract

In this work, we investigated the homoepitaxial growth of silver metal under experimental conditions using kinetic Monte Carlo (KMC). KMC method is a flexible tool for simulating the Physical Vapor Deposition (PVD) process, which involves deposition and diffusion. The method accounts for surface diffusion processes, in addition to nearest-neighbor hopping and including Schwoebel-Ehrlich (SE). The substrate temperature and deposition rate effect on surface roughness have been studied in detail. The simulation results show when increasing the deposition rate, the surface roughness increases due to the size of islands increase [1]. Besides, when the temperature increases, the surface roughness decreases because the islands formed are transformed into a large cluster [1, 2].

keywords: Kintic Monte Carlo, Homoepitaxial, Roughness, Silver, Islands

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*Corresponding author :hassanoutaa903@gmail.com

†Corresponding author :ksbiaai@gmail.com

A Numerical study of an air-cooling channel design attached behind the PV panel

Hafid EL KHARAZ *[a], Kaoutar KHALLAKI[a], M.Saddik KADIRI[a], and K.CHOUKAIRY[a]

[a]LIPIM ENSA Kouribga, Sultan Moulay Slimane University

Abstract

In order to minimize greenhouse gas emissions, renewable energy has become an important solution. Photovoltaic panels are one of these clean and durable energy sources. From 15% to 20% of the solar energy is converted into electricity by using semiconductor materials [1]. The remainder (80%) of the solar radiation is converted to heat and results in a decrease in PV output due to an increase in PV module surface temperature. A 0.5% drop in the performance of a PV module results due to the surface temperature increasing by 1°C [2]. This work aims to study the flow topology of fluid inside a new channel design attached behind PV panel and the impact of different parameters on heat transfer in this cooling system. The 2D Numerical study realized for channel under heat flux uniform (q=300 W/m^2). The K epsilon RNG turbulent model was executed for solving the governing equations. The impact of channel's depth, fins number, and fins length on surface temperature, flow topology and Nusselt number was carried out. The results showed good agreement when compared with experimental results of profile velocity in different sections of the channel. In addition, the correlation obtained for the average Nusselt number is the same as that summarized in much of the literature. The optimum fins number were 10 fins for channel's depth of 90 mm, the surface temperature decreased by 5% compared to the standard channel (without fins). For the new channel design, the surface temperature decreased by 7.2% compared to the standard channel.

keywords: photovoltaic panel, air-cooling, heat transfer, passive active methods, heat exchanger, natural convection

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*Corresponding author :hkharaz@gmail.com

Growth Cu thin film on Si substrate: Morphological and Structural properties

Hassane MES-ADI *[a], Abdelkrim OUKHOYA[a], Mohamed TAHIRI[a], Khalid SAADOUNI[b], and M'hammed MAZROUI[c]

[a] Laboratoire lipim, ENSA Khouribga, Université Sultan Moulay Slimane - Beni Mellal, BP. 145
[b]LISA, ENSA Berrechid, Université Hassan I
[c]Laboratoire de Physique de la Matière Condensée, Faculté des Sciences Ben M'sik, Hassan II University of Casablanca, B.P. 7955

Abstract

In this work, we used molecular dynamics simulation with the modified embedded atom method to study the deposition and annealing of Cu atoms onto the Si (001) substrate. The effects of the substrate temperature, the deposition rate, and the annealing on the morphology and microstructure of the Cu thin film are investigated. Our results show that at a high deposition rate of , the Cu atoms grow following an island-like mode, but when the deposition rate decreases to , the growth mode change significantly and the Cu atoms grow following a layer-by-layer mode. The interface intermixing between Cu atoms and Si substrate is also observed and there are more Cu atoms penetrating into the Si substrate when the substrate temperature and deposition rate increase. On the other hand, based on the radial distribution function, the as-deposited film has an amorphous structure at deposition rates of and of . While at a low deposition rate of , the Cu thin film has a crystalline structure. After the annealing process, the film structure is substantially changed from an amorphous state to a crystalline structure.

keywords: Thin film, Growth, Annealing, Molecular dynamic, Surface roughness, Structure.

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*Corresponding author :mesadihassane@gmail.com

Heat transfer improvement of phase-change materials (PCMs) based thermal control systems for electronic components

Ibtissam Afaynou *[a], Hamza Faraji [b], and Khadija Choukairy[a]

[a]Laboratory of Computer and Mathematical Process Engineering, National School of Applied Sciences, Moulay Slimane University, Khouribga, Morocco
[b]LISA Laboratory, National School of Applied Sciences, Cadi Ayyad University, Marrakech, Morocco

Abstract

Efficient thermal management of electronic components has become a critical issue. The use of phase-change materials (PCMs) based heat sinks is an efficient cooling technology that has attracted the attention of several researchers. However, the low thermal conductivity of PCMs slows the heat removal process. Hence, thermal conductivity enhancers (TCEs) such as fins, foams, and nanoparticles are used to overcome this issue. The aim of this paper is to present a quick review of the effect of each TCE technique applied to PCM-based heat sinks for improving their thermal performance. Recent experimental and numerical investigations are included. According to the literature review, it seems that nanoparticle systems, with interesting heat transfer capabilities are preferable for electronic thermal control. Due to their high thermal conductivity and lightweight than fins and foams as TCEs techniques. Other conclusions and outlooks are introduced.

keywords: PCMs, Thermal control, Thermal conductivity enhancers, Heat sink.

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*afaynouibtissam@gmail.com

Complete Analysis of Acid Hydrolysis of Opuntia Ficus Indica Wastes for Bioethanol Production

Insaf Nori *[a], Salah Touil[a], and Kaoutar Khallaki[a]

[a]LIPIM, Laboratoire d'Ingénierie des Procédés, Informatique et Mathématique, Ecole Nationale des Sciences Appliquées de Khouribga

Abstract

This study presents the findings of an investigation into the acid hydrolysis of Opuntia ficus-indica, cactus pear juice, to produce bioethanol. The study optimized the hydrolysis process using response surface methodology (RSM) with a central composite design (CCD). The optimal conditions for the highest concentration of total reducing sugars and saccharose were determined as 121°C, 3% sulfuric acid, and a solid-to-liquid ratio of 1:10. These conditions resulted in a maximum concentration of 0.13 mol/l of total reducing sugars and 1.42 mol/l of saccharose, achieved in only 17.5 minutes.

keywords: bioethanol, biomass, Opuntia Ficus-Indica, acid hydrolysis, optimization

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*Corresponding author :insaf.nori@usms.ac.ma

Une mini revue sur l'utilisation de la poudre de cactus comme biofloculant dans le traitement des eaux

MEFTAH Khadija *[a], MEFTAH Said[b], ABID Aziza[a], and Touil Salah[a]

[a]Laboratory LaSTI, National School of Applied Sciences, Sultan Moulay Slimane University
[b]Hassan First University of Settat, Faculty of Sciences & Techniques, CAE laboratory

Abstract

La réutilisation d'eaux usées traitées peut être une solution efficace au stress hydrique, les différents produits utilisés aux différents stades de traitement doivent faire l'objet d'une attention particulière, pour cela l'utilisation de cactus dans le traitement de l'eau comme coagulant-floculant à attirer l'attention de plusieurs chercheurs dans les dernières décennies, en raison des avantages qu'il présente, à savoir la biodégradabilité, non-toxicité, ce qui fait de cactus une solution de remplacement des floculants chimiques qui peuvent entraîner des problèmes environnementaux en raison de leur persistance et de leur bioaccumulation dans les organismes vivants, ce travail examine les différentes méthodes de préparation du biofloculants à base de cactus ainsi que l'efficacité de la forme solide dans la réduction de la turbidité, demande chimique en oxygène, matière totale en suspension, matière totale dissoute, les métaux lourds . Ce travail vise également l'études des effets des conditions de préparation et d'application de cactus sur l'efficacité du traitement. Les biofloculants ont montré un très haut rendement dans le traitement de l'eau à l'échelle de laboratoire, mais malheureusement l'industrialisation de ces produits rencontre encore de nombreux problèmes.

keywords: cactus ; opuntia ficus indica ; coagulation /flocculation ;wastewater treatment ; turbidity removal

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*Corresponding author: khadija.meftah.mef@gmail.com

Machine Learning Approaches For Predicting Young's Modulus Of Silica-Based Glasses

M. Sbai Idrissi *[a], A. El hamdaoui †[a], T. Chafiq[b], and S. Ouaskit[a]

[a]Laboratoire de Physique de la Matière Condensée, Faculté des Sciences Ben M'sik, University Hassan II of Casablanca, B.P 7955, Av Driss El Harti, Sidi Othmane, 20670 Casablanca, Morocco

[b]Département de géologie, Faculté des Sciences Ben M'sik, University Hassan II of Casablanca, B.P 7955, Av Driss El Harti, Sidi Othmane, 20670 Casablanca, Morocco

Abstract

In order to develop advanced glasses with exceptional properties, modern technologies require accurate predictions of their physical-chemical properties. Machine learning (ML) has emerged as a powerful tool for predicting these properties, particularly Young's modulus (E) in glasses. This study examines how various ML algorithms can be employed to forecast the E of glasses based on their chemical composition. A dataset of 231 calcium-alumino-silicate (CAS) glass compositions, each with its corresponding E value, was utilized. Four different classes of machine learning methods, namely Linear regression (LR), Polynomial regression (PR), Random Forest (RF), and Multilayer perceptron (MLP), were investigated. Results indicate that the PR method produces excellent predictions without the need for cross-validation (CV), whereas the MLP approach offers superior predictions even with the inclusion of CV.

keywords: glass, machine learning, young's modulus, CAS, cross validation.

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*Corresponding author : mounasbaiid@gmail.com

†Corresponding author :elhamdaouiahmed96@gmail.com

MODELING OF SOLAR RADIATION ON THE GROUND OF KHOURIBGA CITY IN MOROCCO

Mohamed Nfaoui *[a] and Sanaa Hayani-Mounir[a]

[a] Multidisciplinary laboratory of research and innovation (LaMRI), EMAFI Team, University of Sultan Moulay Slimane, Polydisciplinary Faculty, Khouribga, Morocco

Abstract

The study and application of solar energy at a particular site depend on comprehensive and detailed data on the solar radiation at that site. Knowledge of this information is essential in designing and sizing solar energy systems. Therefore, accurate sizing is only possible if measurements are continuously available in space and time. The aim of this work is to present the method used in the calculation and describe the available data by extracting some useful information. To assess the potential for solar energy generation in the region, we study the theoretical solar field available in Khouribga by calculating a series of insolation and solar irradiation data. This allows us to extract the correct angle at which the maximum energy could be absorbed by solar cells.

keywords: Solar Energy, MATLAB programs, Optimal Tilt Angle, Orientation and Inclination.

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*Corresponding author :nfaoui.smp@gmail.com

Surface functionalization of penta-siligraphene monolayer for nanoelectronic, optoelectronic and photocatalytic water-splitting: a first-principles study

M. MAYMOUN *[a], S. OUKAHOU[a], A. ELOMRANI[a], A. BENADDI[a], Y. BAHOU[a,b], and d K. SBIAAI[a]

[a]Sultan Moulay Slimane University of Beni Mellal, Polydisciplinary Faculty of Khouribga, LS2ME Laboratory, B.P. 145, 25000 Khouribga, Morocco

[b]Univ Hassan 1, Laboratoire Rayonnement-Matière et Instrumentation (RMI), Fst Settat, KM 3 B.P. 577 route de Casablanca – 26000, Maroc

Abstract

Herein, we have investigated theoretically using density functional theory the effect of surface functionalization with hydrogen, fluorine and chlorine atoms on electronic and optic properties of the penta-siligraphene monolayer (p-Si2C4). By assessing the stability, we have found that the hydrogenated p-Si2C4 monolayer (p-Si2C4-4H) is energetically (negative formation energy), dynamically (absence of soft modes) and thermally (small drift in the total energy at standard temperature) stable. The electronic-property analysis revealed that the p-Si2C4-4H monolayer is a semiconductor with indirect bandgap varying from 2.06 to 3.41 eV depending on the used functional. Moreover, the p-Si2C4-4H monolayer exhibits a considerable absorption in the ultraviolet (UV) region and a negligible amount of absorption in the visible region. Interestingly, the band edge positions of the p-Si2C4-4H monolayer could perfectly satisfy the redox potentials of photocatalytic water splitting. Our findings suggest the p-Si2C4-4H monolayer as a promising candidate for applications in new generation of nano- and opto-electronics, especially in UV light shielding (for absorbing the harmful-UV radiations), solar cells (as an anti-reflection layers) and photocatalytic water splitting (for hydrogen and oxygen production).

keywords: Density functional theory (DFT), 2D-materials, Surface functionalization, Photocatalytic, penta-siligraphene

*Corresponding author :maymoun17755@gmail.com

Structural, electronic and optical Properties of Ba_2ScSbO_6 Double perovskite oxide compound

Mouad BENNANA *[a], Abderrahmane ABBASSI[a], and Elhadadi BENACHIR[a]

[a]Laboratory of Research in Physics and Engineering Sciences, Sultan Moulay Slimane University, Polydisciplinary Faculty, Beni Mellal, 23000, Morocco.

Abstract

The ordered double perovskite Ba_2ScSbO_6 (BSS) has been investigated using Density Functional Theory (DFT) study of the electronic properties has been carried out using the Full-Potential Linear Augmented Plane Wave (FP-LAPW) as implemented in WIEN2k. The crystal structure is found to be cubic, with space group Fm-3m (No.225) and lattice parameter, $a = 8.1891$Å. The calculated optical band-gap is 4.038 eV. BSS is found to be a large band-gap insulator with potential technological applications.

keywords: DFT, Perovskite, wien2K

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*Corresponding author :mouadbennana@gmail.com

STUDY AND THERMODYNAMIC MODELLING OF THE BEHAVIOR OF CADMIUM IN THE PO4-SO4-H2O SYSTEM, FOR MOLARITY CONDITIONS RANGING FROM DILUTION TO SATURATION AND AT TEMPERATURES BETWEEN 298,15K AND 353,15K

Raja BELKHAIR *[a] and Lhachmi KHAMAR[a]

[a]LIPIM, Laboratory of Process Engineering, Informatics and Mathematics, National school of applied Sciences in Khouribga, Sultan Moulay Slimane University.

Abstract

Industrial phosphoric acid (PAC) is produced mainly from phosphate rock by wet processes. Although these processes are economically and energetically very competitive, they have the disadvantage of producing not pure phosphoric acid profiles that contain undesirable impurities. One of these impurities is cadmium, which is initially contained in the phosphate rock and is directly transferred to the acid produced during the leaching of phosphates. In order to develop processes and innovative methods for the removal of cadmium from PAC, the present work aims to study the thermodynamic behavior of this impurity in the PO4-SO4- H2O system. It is indeed about the study of speciation of cadmium in aqueous phase and determination of the solubilities of the mineral phases being able to integrate in their structures this chemical element and which are likely to be formed during the manufacturing process of the PAC. The experimental and thermodynamic modeling study was carried out for molarity conditions ranging from dilution to saturation and for temperatures comprised between 298.15K and 353.15K. The perdition results of the thermodynamic models are in good agreement with those in the literature and those measured experimentally

keywords: Cadmium, Phosphoric acid, Modeling, Thermodynamics, Processes.

*Corresponding author :raja.belkhair@usms.ac.ma

Enhancing the electrochemical performance of olivine $LiMnPO_4$ as cathode materials for Li-Ion Batteries by Ni-Fe co-doping

S. Oukahou *[a], M. Maymoun[a], A. Elomrani[a], A. Benaddi[a], M. Lamhani[a], K. Sbiaai[a], and A. Hasnaoui †[a]

[a]Sultan Moulay Slimane University of Beni Mellal, Polydisciplinary Faculty of Khouribga, LS2ME Laboratory, B.P. 145, 25000 Khouribga, Morocco.

Abstract

In this work, DFT calculations were performed to investigate the effect of Ni-Fe co-doping (i.e. $LiMn_{0.5}Ni_{0.25}Fe_{0.25}PO_4$) on the structural, electronic, magnetic, electrochemical potential and kinetic properties of Li-ion in pristine LMP as well as on the thermodynamic stability, theoretical capacity, charge transfer, average M-O bond lengths and electrical conductivity. We also examined the thermodynamic stability and charge transfer of Ni/Fe single-doping in lithiated/delithiated ($LiMnPO_4/MnPO_4$) pristine phases, i.e., LMNP/MNP ($LiMn_{0.5}Ni_{0.5}PO_4/Mn_{0.5}Ni_{0.5}PO_4$) and LMFP/MFP ($LMn_{0.5}Fe_{0.5}PO_4/Mn0.5Fe_{0.5}PO_4$). Our calculations indicated that all compounds are thermodynamically stable. A small change in unit cell volume between lithiated and delithiated phases for all structures was observed, indicating good reversibility during Li insertion/extraction. Electronic properties analysis revealed that Ni-Fe co-doping reduces the bandgap of LMP from 3.62 to 1.55 eV, indicating that Ni-Fe co-doping can improve the electronic conductivity of LMP. Furthermore, the migration barrier energy of Li-ion in MNFP (0.34 eV) is lower than that in MP (0.40 eV), implying that Ni-Fe co-doping is beneficial for improving the ionic conductivity of Li-ion pristine MP. This study suggests that LMNFP could be a promising cathode material for highperformance lithium-ion batteries. Simultaneously, this study is crucial for better understanding the effect of Ni-Fe co-doping on the performance of LMP as a cathode material for LIB batteries.

keywords: Density functional theory, lithium-ion batteries, $LiMnPO_4$, Barrier energy, Codoping.

*Corresponding author :oukahousaid40@gmail.com

†Corresponding author :hasnaoui59@hotmail.com

Modelling the behavior of pharmaceutical powders in compression

S. Ramli *[a] and My. S. KADIRI[a]

[a]Laboratory of Process Engineering, Computer Science and Mathematics (LIPIM), National School of Applied Sciences, Khouribga, Morocco

Abstract

Pharmaceutical powder compaction is a crucial process in tablet production that offers numerous benefits, including efficient production, consistency, cost-effectiveness, and enhanced tablet properties. It also has some limitations that must be considered. One limitation is that the compaction process can lead to the formation of defects in the tablets, such as cracks, splits, or capping, which can affect the mechanical strength, dissolution rate, and stability of the tablet. The use of numerical simulation can be relied upon to identify and fix these limitations by providing a cost-effective and efficient means of optimizing the compaction process and predicting the quality and properties of the final product. Tablet production involves various factors specific to the powders used, such as their coefficient of friction, mechanical behavior, and modulus of elasticity. Die compaction of the powder mixture causes a decrease in volume due to elastic and plastic deformations sustained by the particles. Elasto-plastic behavior is the most commonly considered densification mechanism. Numerical simulation plays a significant role in optimizing the manufacturing process. There are two main approaches to modelling compact compression: discrete and continuous. Several simulation models have been developed using both approaches. This article introduces the various modelling methods developed so far, highlighting their principles, approaches, advantages, and limitations to provide a solid starting point for researchers in the field.

keywords: Die compaction, Pharmaceutical Powder Compression, Numerical modelling, Elasto-Plastic Properties, Finite Element Method, Multi-particle Finite Element Method, Discrete Element Method, Meshless Method.

*Corresponding author: sara.ramli@usms.ma

Optimization of firing temperature for better physical properties of clay bricks: A study on four different clay types

ABOULOIFA Walid *[a], ETTAKI Mohammed[b], and HAYANI MOUNIR Sanaaa[a]

[a]Multidisciplinary Laboratory of Research and Innovation (LMRI), EMAFI Team, Polydisciplinary Faculty of Khouribga, Sultan Moulay Slimane University, Morocco.
[a]Geosciences Semlalia Laboratory, Faculty of Sciences Semlalia, Cadi Ayyad University, Marrakech 40000, Morocco Corresponding author

Abstract

Fired clay brick is one of the most widely used conventional construction materials throughout the world. The production cost of clay brick is significantly affected by the cost of energy required for firing. The aim of this study is to investigate the effects of different firing temperatures on the physical properties of fired clay bricks produced from four different types of clay and evaluate the effect of firing processes in brick manufacturing on the properties, color, and appearance of the clay bricks. In this study, the effect of firing temperature on the physical properties of clay bricks made from four different types of clay was investigated. The four clay types were selected based on their diverse chemical and mineral composition, which could affect their physical properties. Clay bricks were manually formed and then fired at temperatures ranging from 800°C to 1000°C in steps of 100°C. Thermal conductivity (TC), apparent porosity (P), water absorption (WA), bulk density (D) and Firing shrinkage (FS) of the fired bricks were measured after each firing cycle to assess the effects of the firing temperature on these physical properties. The study revealed that each type of clay had unique physical properties that affected the behavior of the fired bricks.

keywords: Fired Clay Brick, Firing Temperature, Sustainability, Thermal properties

*Corresponding author :walidabouloifa@gmail.com

Part IV

Fundamental and Applied Mathematics

Some Equilibrium Problems via Ekeland's Variational Principle

DOUHOU Abdessamad *[a]

[a]Equipe de Mathématiques et Applications, Faculté des Sciences et Techniques de Béni Mellal, Maroc,

Abstract

In this work, we seek to study the existence of solutions for some equilibrium problems in metric spaces without assuming the convexity and monotonocity of functions. We take to use the Ekeland's variational principle for functions that are not necessarily lower semi-continuous. To over come this problem, we use a weaker type of continuity called transfer lower continuity.

keywords: Equilibrium problem, Quasi-equilibrium problem, Minimization problem, Semi-continuity, Transfer continuity, Ekeland's variational principle.

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Coupling local and nonlocal diffusion equations for image denoising

AMIN BOUKDIR [*a], MOURAD NACHAOUI [†a], and AMINE LAGHRIB [‡a]

[a]EMI FST,Sultan Moulay Slimane University, Morocco

Abstract

Nonlocal equations have generated a great deal of attention for imagine denoising because of their potent capacity to restore textures and features in images. However, the restored images still contain some noise because of the lack of regularity. In this research, we propose and investigate a weighted local and weighted nonlocal p-Laplacian evolution equation. On the basis of the supposition that the weights disappear in sets of positive measure, the existence and uniqueness of solutions to the suggested equation are demonstrated. We also demonstrate how, if the kernel is correctly rescaled, solutions to the proposed equation converge to those of the standard p-Laplacian equation. For the purpose of eliminating Gaussian noise from images, comparisons with local and nonlocal diffusion equations are offered.

keywords: Nonlocal diffusion, p-Laplacian equation, Image denoising.

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[*]Corresponding author :aminboukdir111@gmail.com

[†]:nachaoui@gmail.com

[‡]:laghrib.amine@gmail.com

Uncertainty principles for the offset linear canonical transform

DAHER Radouane *

Abstract

We extend some different uncertainty principles (UPs), including Miyachi's UP and Morgan's UP for the offset linear canonical transform (OLCT) which provides a more general framework for a number of well-known linear integral transforms such as Fourier transform, fractional Fourier transform, linear canonical transform.

keywords: Offset linear canonical transform · Uncertainty principles · Miyachi's uncertainty principles · Morgan's uncertainty principles.

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*: r.daher@fsac.ac.ma

On the existence of solution to nonlinear elliptic equation with variable exponent and singular lower order term

Abdellatif Bouhal *[a], Hichem khelifi †[b], and Youssef El Hadfi ‡[a]

[a]Department of Mathematics and Informatics, National School of Applied Sciences, Sultan Moulay Slimane University, BP 77 Bd Beni Amir, Khouribga, 25000, Khouribga, Morocco.
[b]Department of Mathematics and Informatics, University of Algiers, 2 Street Didouche Mourad, Algiers, 16002, Algiers, Algeria. 3 Laboratory of Mathematical Analysis and Applications, University of Algiers 1, Algiers, Algeria. Laboratory of Mathematical Analysis and Applications, University of Algiers 1, Algiers, Algeria.

Abstract

In this paper, we prove the existence of weak solutions for a some nonlinear elliptic equations which contain a singular lower order gradient term and an L1(Ω) datum, in the framework of Sobolev spaces with variable exponents. Additionally, we prove that the presence of the lower order term leads to a regularizing effect on the solutions,.

keywords: Variable Sobolev spaces; Elliptic equation, Singular gradient lower order term

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Deep Learning for Mean Field Optimal Transport

S.Baudelet *[a], B.Frénais †[b], M.Laurière ‡[c], A.Machtalay §[d], and Y.Zhu ¶[e]

[a]Université Côte d'Azur, Nice - France
[b]Université de Strasbourg, Strasbourg - France
[c]cNYU-ECNU Institute of Mathematical Sciences at NYU Shanghai, Shanghai - China
[d]Mohammed VI Polytechnic University, Ben Guerir - Morocco
[a]Yale University, New Haven - USA

Abstract

Mean field control (MFC) problems have been introduced to study social optima in very large populations of strategic agents. The main idea is to consider an infinite population and to simplify the analysis by using a mean field approximation. These problems can also be viewed as optimal control problems for McKean-Vlasov dynamics. They have found applications in a wide range of fields, from economics and finance to social sciences and engineering. Usually, the goal for the agents is to minimize a total cost which consists in the integral of a running cost plus a terminal cost. In this work, we consider MFC problems in which there is no terminal cost but, instead, the terminal distribution is prescribed. We call such problems mean field optimal transport problems since they can be viewed as a generalization of classical optimal transport problems when mean field interactions occur in the dynamics or the running cost function. We propose three numerical methods based on neural networks. The first one is based on directly learning an optimal control. The second one amounts to solve a forward-backward PDE system characterizing the solution. The third one relies on a primal-dual approach. We illustrate these methods with numerical experiments conducted on two families of examples [1].

keywords: Deep Learning, Mean field control, Mean Field Optimal Transport.

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*Corresponding author :sebastian.baudelet@univ-cotedazur.fr
†brieuc.frenais@math.unistra.fr
‡mathieu.lauriere@nyu.edu
§amal.machtalay@um6p.ma
¶yuchen.zhu@yale.edu

Existence of solution for a coupled diffusion PDE system for various noise reduction

A. MOHSSINE *[a], L. AFRAITES †[a], A. LAGHRIB ‡[a], and A. HADRI §[a]

[a]EMI FST,Sultan Moulay Slimane University, Morocco

Abstract

In this work, we introduce a new model based on a high-order, non-linear PDE system for image denoising, which is controlled by a function h that detects the type of noise. The proposed model generalizes and improves upon the coupled PDE system of Jain et al. (2019) [1], allowing for the handling of various noise types, such as Gaussian, Speckle, and Salt & Pepper's noise. Our model is based on a diffusion tensor that corrects the anisotropic, coherent diffusion property of the Weickert operator near tiny edges with a high diffusion order. This configuration exhibits flexibility in the diffusion speed [2], allowing for efficient smoothing near flat areas without changing directions along the edges or across them. We perform a rigorous analysis of the existence and uniqueness of the weak solution of the proposed coupled PDE system in a suitable functional framework, using the Schauder fixed-point theorem. Finally, we present representative numerical results to demonstrate the effectiveness of our model against various noise types, by comparing the obtained results with those of some competitive models.

keywords: Image denoising, Inverse problem, Fix-point.

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*Corresponding author :ayoub.mohssine@edu.uca.ac.ma

†:lekbir.afraites@gmail.com

‡:laghrib.amine@gmail.com

§:aissam.hadri@gmail.com

Application of the fractional optimal control network (FOCNet) in image denoising.

Limami Fakhr-eddine *[a], Lekbir Afraites †[a], Aissam Hadri ‡[b], and Amine Laghrib §[c]

[a]EMI FST Béni-Mellal, Université Sultan Moulay Slimane, Béni Mellal, Morocco
[b]Lab SIV, Université Ibn Zohr, Agadir, Morocco
[c]LMA, FST Béni-Mellal, Université Sultan Moulay Slimane, Morocco

Abstract

Recently, many researches have established a relationship between neural networks, fractional differential equations (FDEs) and control theory. These works have opened up a new perspectives for using the proven theory of FDE to explore new neural network architectures. In this talk, we focus on the fractional optimal control network (FOCNet) and its application to advanced image denoising. For this reason, we first discuss the general functioning of DCNN, and then show how it is used in particular for image denoising. Next, we discuss the notion of optimal control and how it relates to DCNN. Furthermore, we present a fractional optimal control network for image denoising (FOCNet) and recall the architecture of FOCNet. Finally, we present some numerical experiments.

keywords: Fractional Optimal Control, image denoising, neural networks.

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*fakhr.limami@gmail.com
†lekbir.afraites@gmail.com
‡aissamhadri20@gmail.com
§a.laghrib@usms.ma

A Priori Error Estimates of Piezoelectric Contact Problem with and without Friction

Hamid El Khalfi *[a], Othmane Baiz †[b], and Hicham Benaissa ‡[c]

[a]FP of Khouribga, Sultan Moulay Slimane University, Morroco,
[b]FP of Ouarzazate, Ibno Zohr University, Morroco,
[c]FP of Khouribga, Sultan Moulay Slimane University, Morroco,

Abstract

This paper deals with a study the linear finite element approximation of a piezoelectric Signorini's contact problem with and without Tresca's friction law. We derive error estimates which depend on the penalty parameter ε and the mesh size h. In fact, under some regularity of the solution of the contact problems and with some requirements on $\epsilon > h$, we prove a convergence rate of $O\left(h^{\frac{1}{2}+v} + \epsilon^{\frac{1}{2}+v}\right)$ in the energy norm. Therefore, if the penalty parameter is taken as.

keywords: Piezoelectric material, Signorini's conditions, Tresca's law, Priori estimate, Finite elements, Penalty method

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*:e.hamidos20@gmail.com
†: othman.baiz@gmail.com
‡:hi.benaissa@gmail.com

Periodic solutions for a degenerate double phase parabolic equation with variable growth

Hamza JOURHMANE*[a], Abderrezak KASSIDI †[a], M'hamed ELOMARI ‡[a], and Khalid HILAL §[a]

[a] Laboratory LMACS, Faculty of Science and Technology of Beni Mellal, Sultan Moulay Slimane University, Beni Mellal, Morocco.

Abstract

The purpose of this work is the investigation of a degenerate parabolic equation with double phase phenomena, variable growth and strongly nonlinear source under Dirichlet boundary conditions, the existence of a periodic non-negative weak solution is established. Our proof will be based on the Leray-Schauder topological degree, which presents several issues for this kind of equations, but were overcome by using different techniques and known theorems. The system considered is a possible model for problems where the entity studied has different growth coefficients, p(x) and q(x) in our case, that varies with the position where the growth is calculated.

keywords: Generalized Sobolev spaces, Topological degree, Dirichlet conditions, Periodic solution.

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*:hamzajourh@gmail.com

†: abderrazakassidi@gmail.com

‡m.elomari@usms.ma

§khalid.hilal.usms@gmail.com

Impact of Breast Cancer Treatment on Heart Health: Mathematical Modeling and Numerical Simulation

El Karchani Maryem*[a] and Nadia Idrissi Fatmi †[a]

[a]Laboratory LIPIM, National School of Applied Sciences (ENSA), University of Sultan Moulay Slimane, Khouribga, Morocco

Abstract

Breast cancer is the second most common cause of death among women around the world. Cancer treatment aims to eliminate cancer cells through therapies, surgical removal, or inhibiting the signals necessary for cell division. However, it is important to note that the impact of cancer treatment on patients may not always be positive. In the case of breast cancer, chemotherapy can have adverse effects on heart health, leading to cardiotoxicity as a notable side effect. In this work, we present mathematical models in epidemiology that play a significant role in predicting the evolution of infectious diseases. Therefore, this study aims to study the various kinds of compartment models: SI, SIR, SEIR...Then, we study the influence of a quantity of very important threshold in epidemiological mathematics called the basic reproduction number R0 on the presented models, thus allowing to assimilate the evolution of any infectious disease. Finally, we constructed a mathematical model based on the population of breast cancer patients at the hospital. A population consists of five subpopulations. These include stages 1 and 2(A), 3(B), 4(C), without disease (D), and cardiotoxic (E). The results obtained are presented through numerical simulations.

keywords: Mathematical Modeling- Epidemiology- compartment models - Basic reproduction num- ber - Breast Cancer- Cardiotoxicity- Cancer Stage- Numerical simulation.

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*:elkarchani.maryem@gmail.com

†:nadidrissi200133@gmail.com

On 1-Laplacian elliptic problems involving a singular term

Mohamed El Hichami *[a] and Youssef El Hadfi 2 †[a]

[a]Sultan Moulay Slimane University, National School of Applied Sciences, Bd Beni Amir, BP 77 , Khouribga, Morocco

Abstract

In this paper, we look at the problem

$$\begin{cases} -\Delta_p u + |\nabla u|^p = fh(u) & \text{in } \Omega, \\ u \geq 0 & \text{in } \Omega, \\ u = 0 & \text{on } \partial\Omega, \end{cases}$$

with Ω is a bounded open subset of R^N with Lipschitz boundary, $\Delta_p u$ is the p-laplacian operator for $1 \leq p < N$, $f \in L^1(\Omega)$ is nonnegative and h is a continuous function that may be singular at $s = 0^+$. We will demonstrate the existence of solutions in the case $1 \leq p < N$. Moreover, if $p = 1$, $f > 0$ and h is decreasing, we will show the uniqueness of the solutions.

keywords: Singular elliptic equations, p-Laplacian, 1-Laplacian, functions of bounded variations, L^1-data.

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*Corresponding author :elhichami.7@gmail.com

†:yelhadfi@gmail.com

Investigation the existence of solution to Coupled system of Nonlinear Impulsive Hybrid Differential Equations with Linear and Nonlinear Perturbations

Mohamed Hannabou *[a]

[a]Sultan Moulay Slimane University, Multdisciplinary Faculty, Department of Mathematics , BP 523, 23000, Beni Mellal, Morocco

Abstract

In this paper, we prove the existence and uniqueness of solutions to impulsive coupled system of nonlinear hybrid fractional differential equations with linear and nonlinear perturbations. Our results are based on the nonlinear alternative of Leray-Schauder type and Banach's fixed-point theorem. On example are included to show the applicability of our results. perturbation.

keywords: Coupled systems; Impulsive hybrid fractional differential equations; Fixed point theorems; linear

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*Corresponding author :hnnabou@gmail.com

Parameter recovery of an epidemic model with continuous data assimilation

Mohammed Azoua [*a], Abderrahim Azouani [†a], and Imad Hafidi [‡a]

[a]Sultan Moulay Slimane University, National School of Applied Sciences, Bd Beni Amir, BP 77, Khouribga, Morocco.

Abstract

We study the numerical performance of a continuous data assimilation algorithm, based on ideas from feedback control theory of dynamical systems, in the context of compartimental mathematical model of SEIR pandemics. The motivation of this work is the estimation of some parameters as contact parameter in the SEIR model. This system may have limited predictive value due to idealized assumptions underlying the model, measurement error in experimental data and parameters. We implement this model as paradigm in view of application to more realistic epidemic models. The comparison betwen our nudging data assimilation method end the sequential stochastic data assimilation is provided.

keywords: Parameter estimation, Data assimilation, Azouani-Olson-Titi (AOT) algorithm, Inverse problems.

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[*]:mohammed.azoua00@gmail.com

[†]: azouani@math.fu-berlin.de

[‡]:i.hafidi@gmail.com

Karama-Hamdi Method(KHM)

M.Karama *[a] and M. Hamdi †[b]

[a]university Sultan Moulay Slimane, Faculty of Sciences Technology-beni Mellal, Morocco
[b]University Abdlmalek Essaadi, Faculty of Science and Technology-Al Hoceima, Morocoo.

Abstract

This abstract examines periodic-vibration at Dynamical system with Duffing oscillator that is subjecting to the galloping force of the seventh degree by new method named Karama-Hamdi Method (KHM). This method is based on transformed the dynamical system of the second degree that written as $\ddot{x} = (\mathrm{t}, x, \dot{x})$ to another dynamical system of the primary degree that written as $\dot{x} = \boldsymbol{\psi}(\mathrm{t}, x)$ and we compared (KHM) with Multi Scale Method(MSM) where we based on two reference at [1, 2]. To investigates from this study, We have studied the stability chart that gave us three zones, Where first zone stable periodic, second zone unstable periodic and third zone trivial solution(leads to zero), And we could specify SN and Hopf bifurcation at this system. At the end we have confirmed these analytical methods with numerical simulation where we found a good result.

keywords: Karama-Hamdi Method(KHM), Duffing oscillator, The galloping force of the seventh degree.

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*:mohammedyasir110@gmail.com
†:

Approximate Efficient Solutions of Nonsmooth Multiobjective Bilevel Programming Problem

Mohsine Jennane*[a]

[a] FSDM, Department of Mathematics, Sidi Mohamed Ben Abdellah University, Fez, Morocco.

Abstract

In this work, we formulate both necessary and sufficient optimality conditions for approximate efficient solutions of a nonsmooth multiobjective bilevel programming problem under a suitable constraint qualification and using convexificators.

keywords: Bilevel programming, optimality conditions, approximate efficient solutions, convexificators, constraint qualifications.

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*: mohsine.jennane@usmba.ac.ma

Stochastic optimal switching and systems of variational inequalities with interconnected obstacles

Brahim EL ASRI*[a], Imad FAKHOURI †[a], and Nacer OURKIYA ‡[a]

[a] Université Ibn Zohr, Labo. LISAD, Equipe. Aide à la decision, ENSA, Agadir, Maroc .

Abstract

This paper studies a system of m variational inequalities with interconnected obstacles in infinite horizon associated to optimal multi-modes switching problems. Our main result is the existence and uniqueness of a continuous solution in viscosity sense, for that system. The proof of the main result strongly relies on the connection between the systems of variational inequalities and reflected backward stochastic differential equations (RBSDEs) with oblique reflection, which will be characterized through a Feynman-Kac's formula. The main feature of our system of infinite horizon RBSDEs is that its components are interconnected through both the generators and the obstacles.

keywords: Reflected backward stochastic differential equations, Switching problem, Oblique reflec- tion, Viscosity solution, Variational inequalities, Infinite horizon.

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*:b.elasri@uiz.ac.ma

†: i.fakhouri@uiz.ac.ma

‡:nacer.ourkiya@edu.uiz.ac.ma

Finite time stability analysis of delayed fractional differential equations with respect to another function

Naoufel Hatime *[a], Said Melliani †[a], M'hamed Elomari ‡[a], and ALI EL MFADEL §[a]

[a]Laboratory of Applied Mathematics and Scienti?c Computing, Sultan Moulay Slimane University, Beni Mellal, Morocco

Abstract

In this work, we study the existence, uniqueness and finite-time stability results for fractional delayed Newton coolinglaw equation involving Φ- Caputo fractional derivatives of order $\alpha \in (0, 1)$. By using Banach fixed point theorem, HenryGronwall type retarded integral inequalities and some techniques of -Caputo fractional calculus, we establish the existence and uniqueness of solutions for our proposed model. Based on heat transfer model, a new criterion for finite time stability and some estimate results of solutions with time delay are derived. In addition, we give some specific examples with graphs and numerical experiment to illustrate the obtained results. More importantly, the comparison of model predictions versus experimental data, classical model and non-delayed model show the effectiveness of our proposed model with a reasonable precision.

keywords:

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*Corresponding author :hatime.naoufel@usms.ma

†:m.elomari@usms.ma

‡:abderrazakassidi@gmail.com

§:a.elmfadel@usms.ma

Learning from noisy data using Gaussian Kernel And Bi-Level Optimization

N. Hafidi *[a], M. Nachaoui †[a], and I. Hadri ‡[b]

[a]EMI, Université Sultan Moulay Slimane, Béni Mellal. Maroc.
[b]Lab SIV, Université Ibnou Zohr, Agadir, Maroc

Abstract

Noise infecting data is inevitable. This makes the problem of machine learning a very challenging task. This work proposes an approach that can predict models based only on noisy data. We show that our approach can achieve good performance in prediction tasks even with high levels of noise. Moreover, as it is well known, machine-learning performance depends on many parameters so-called hyperparameters. These parameters are unknown and there is no knowledge about their estimations. The developed approach proposes an algorithm that can automatically determine the models together with some hyperparameters that influence the performance of the machine learning results.

keywords: Machine-learning, Gaussian kernel, hyperparameters, Optimization, Gradient-based method .

References

[1]

[2]

*:mr.na.hafidi@gmail.com
†:
‡:

Mellin transforms and generalized Lipschitz spaces

Radouan Daher *[a] and Othman Tyr †[a]

[a]Department of Mathematics, Faculty of Sciences Aïn Chock, University Hassan II, Casablanca, Morocco

Abstract

The aim of this research is to study the smoothness property of a function with an absolutely convergent Mellin transform. More precisely, we study the order of magnitude of the Mellin transform for complex- valued functions belonging to the generalized Mellin Lipschitz and Zygmund classes.

keywords: Mellin transforms, Mellin translation operator, Lipschitz classes

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*Corresponding author :

†Corresponding author : otywac@hotmail.fr

TUBERCULOSIS WITH CONTAMINATION BY THE CONSUMPTION OF UNPASTEURIZED DAIRY PRODUCTS: MATHEMATICAL MODELLING AND NUMERICAL SIMULATIONS

Rizlane Zahli*[a] and Nadia Idrissi Fatmi †[a]

[a]Laboratory LIPIM, National School of Applied Sciences (ENSA), University of Sultan Moulay Slimane, Khouribga, Morocco

Abstract

In this article, we present a mathematical model of transmission tuberculosis which takes account the contamination by consuming unpasteurised dairy products. We have determined the equilibrium points, whose local stability is guaranteed by Lyapunov's indirect method using the Routh-Hurwitz stability criterion. The results obtained show that, even if there are no bacteria in the environement, the probability of infection with tuberculosis remains high, and this is due to the consumption of unpasteurised dairy products. Finally, we introduce some numerical simulations graphics to validate our results.

keywords: tuberculosis; unpasteurised dairy products; stability analysis; numerical simulation.

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*:ghizlanezahli93@gmail.com

†:nadidrissi200133@gmail.com

Existence of anti-periodic solutions for ϕ-Caputo-type fractional p-Laplacian problems via Leray–Schauder degree theory

Sami Baroudi*[a], Abderrezak KASSIDI †[a], Ali El MFadel ‡[a], and M'hamed ELOMARI §[a]

[a] Laboratory of Applied Mathematics and Scientific Computing, Sultan Moulay Slimane University, Beni Mellal, Morocco.

Abstract

The purpose of this work is the investigation of a degenerate parabolic equation with double phase phenomena, variable growth and strongly nonlinear source under Dirichlet boundary conditions, the existence of a periodic non-negative weak solution is established. Our proof will be based on the Leray-Schauder topological degree, which presents several issues for this kind of equations, but were overcome by using different techniques and known theorems. The system considered is a possible model for problems where the entity studied has different growth coefficients, p(x) and q(x) in our case, that varies with the position where the growth is calculated.

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*:samibaroudi.fstbm@gmail.com

†: abderrazakassidi@gmail.com

‡a.elmfadel@usms.ma

§m.elomari@usms.ma

EXISTENCE OF ANTI-PERIODIC SOLUTIONS FOR $\varphi - CAPUTO$ FRACTIONAL p-LAPLACIAN PROBLEMS VIA TOPOLOGICAL DEGREE METHODS

WALID BENHADDA *[a], M'HAMED ELOMARI †[a], ABDERRAZAK KASSIDI ‡[a], and ALI EL MFADEL §[a]

[a]Laboratory of Applied Mathematics and Scienti?c Computing, Sultan Moulay Slimane University, Beni Mellal, Morocco

Abstract

The main crux of this paper is to investigate the existence of solutions for anti-periodic nonlinear $\varphi - Caputo$ fractional di?erential equations with p-Laplacian operators. Our main results are demonstrated by applying topological degree methods of condensing maps and several properties of $\varphi - Caputo$ fractional calculus paired with measures of noncompactness. To show the practical signi?cance of our theoretical results, we provide a nontrivial example at the end.

keywords:

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*Corresponding author :benhadda.walid@gmail.com

†:m.elomari@usms.ma

‡:abderrazakassidi@gmail.com

§:a.elmfadel@usms.ma

Degree of Freedom for Eldord and Adams model

Youssef Essadaoui 1*[a] and Imad Hafidi 1†[a]

[a]Sultan Moulay Slimane University, National School of Applied Sciences, Bd Beni Amir, BP 77, Khouribga, Morocco.

Abstract

This paper presents a novel approach to solve the equilibrium problem with a single degree of freedom in fluid-structure interactions. To model the fluid pressure, we introduce a new approach based on the Eldrod and Adams model $\nabla \cdot \left[(h_0 + a)^3 \nabla p\right] = \frac{\partial h_0}{\partial x_1}$. Which accurately simulates the dynamic behavior of fluids. Our analysis demonstrates the validity of Reynolds' equation for general geometrical shapes, extending previous results in dimensions 1 and 2 for plane surfaces. Furthermore, we establish the existence of solutions for the dynamic problem with only one degree of freedom under certain conditions. The resulting method is a valuable tool for designing and analyzing real-world structures, providing new insights into the behavior of fluid-structure interactions and paving the way for future research in this field.

keywords: Eldrod and Adams, asymptotic behaviour, Lubrication, inequation of Reynoldss.

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*Corresponding author :youssefessadaoui2017@gmail.com
†i.hafidi@usms.ma

New coupled system for image denoising based on a variable exponent PDE

Z. Zaabouli [*a], L. Afraites [†b], A. Laghrib [‡b], and A. Hadri [§b]

[a]EMI, Sultan Moulay Slimane University, Morocco. bLAB SIV, Ibn Zohr University, Morocco.

Abstract

We consider the following coupled system that involve $p[u]$-Laplacian operator :

$$\begin{cases} \frac{\partial u}{\partial t} - \operatorname{div}\left(B(u)|\nabla u|^{p[u]-2}\nabla u\right) + \lambda w = 0 & \text{in } Q := (0,T)\times\Omega, \\ \frac{\partial w}{\partial t} = \eta\Delta w - (f-u) & \text{in } Q := (0,T)\times\Omega, \\ \nabla w\cdot\vec{n} = B(u)|\nabla u|^{p[u]-2}\nabla u\cdot\vec{n} = 0 & \text{in } \Sigma := (0,T)\times\partial\Omega, \\ u(0,x) = f, \quad w(0,x) = 0 & \text{in } \Omega, \end{cases}$$

where $\lambda, \eta > 0$ and $p[u]$ defined as fallow: $p[u] \equiv p(S(|u|))$, where the function $p : \mathbb{R} \mapsto [p^-, p^+]$is the edge detector function, and

$$S(|u|) = \int_\Omega |u(x,t)|^\alpha dx : L^\infty\left(0,T; L^\alpha(\Omega)\right) \mapsto \mathbb{R}, \quad 1 \le \alpha \le 2.$$

In this work we proved the existence and uniqueness of a weak solution for the problem (1) by Galerkins method then we provide a discretization for the problem (1). After that, we implement the given discretization and through the analysis of experimental results, we demonstrate the effectiveness of this model in image restoration while comparing it to other competing models.

keywords: Image denoising, coupled PDE system, variable exponent PDE, Galerking approximation.

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[*]:zaabouliziad@gmail.com
[†]: l.afraites@usms.ma
[‡]:laghrib.amine@gmail.com
[§]: aissam.hadri@gmail.com

A New Mathematical Model of the spread of Covid-19 among Diabetes population:Analysis and Optimal control approach for intervention strategies

Imken Ikrama *[a], Nadia Fatmi Idrissia 2 †[a], and Saloua El Amarib 2 ‡[b]

[a]Sultan Moulay Slimane University, National School of Applied Sciences, Bd Beni Amir, BP 77 , Khouribga, Morocco

[b]Department of Endocrinology, Diabetology, Metabolic Disease and Nutrition, Mohammed VI University of Health Sciences, Casablanca., Morroco

Abstract

In this work we study an original mathematical model describing the association of Diabetes and Coronavirus.The first aim is to know the impact of the virus on the diabetics and to protect them. We analysis the mathematical model by using Routh–Hurwitz criteria, the local stability of Corona-Diabetes-free equilibrium and Corona-Diabetes equilibrium are obtained.The second aim of this paper is to reduce the number of infected with complication by control strategies using three variables of controls that represent respectively, the awareness program to diabetic people, also the permanent glycemic control in hospital with follow up and health monitoring the diagnostic of diabetic people in the first step of transmission of the virus.Theoretically, we have proved the existence of optimal controls, and a characterization of the controls in terms of states and adjoint functions principally based on Pontryagin's maximum principle and the optimality system is solved by an iterative method . Finally, to clarify the efficiency of our theoretical results, we provide numerical simulations for numerous scenarios. Therefore, the obtained results affirm the performance of the optimization approach.

keywords: Diabetes,Mathematical Model,Local Stability,Optimal Control.

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*Corresponding author :

†:

‡:

The Stability Analysis Of An Epidemiological Model "All Coronavirus mutations" With Fractional Time Derivative

Khadija CHANNAN *[a], Khalid HILAL †[a], and Ahmed KAJOUNI ‡[a]

[a]1LMACS, Sultan Moulay Slimane University of B´eni Mellal, Morocco

Abstract

We have all been injured by corona and its mutations, not just us but the whole world ; because of this we have created a new epidemiological model which models all the mutations of covid 19 (Omicron, the English variant, delta,...). This paper is concerned with a fractional order model involving the caputo fractional derivative. The equilibrium points and the basic reproduction number are computed. An analysis of the asymptotic stability at the disease free equilibrium is given; Next, we study the stability of the equilibrium points in the sense of mittag-Leffler.

keywords: The equilibrium points, mittag-Leffler, caputo fractional.

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*Corresponding author :channankhadija@gmail.com

†:

‡:

EXISTENCE OF ANTI-PERIODIC SOLUTIONS FOR $\varphi - CAPUTO$ FRACTIONAL p-LAPLACIAN PROBLEMS VIA TOPOLOGICAL DEGREE METHODS

WALID BENHADDA *[a], M'HAMED ELOMARI †[a], ABDERRAZAK KASSIDI ‡[a], and ALI EL MFADEL §[a]

[a]Laboratory of Applied Mathematics and Scienti?c Computing, Sultan Moulay Slimane University, Beni Mellal, Morocco

Abstract

The main crux of this paper is to investigate the existence of solutions for anti-periodic nonlinear $\varphi - Caputo$ fractional di?erential equations with p-Laplacian operators. Our main results are demonstrated by applying topological degree methods of condensing maps and several properties of $\varphi - Caputo$ fractional calculus paired with measures of noncompactness. To show the practical signi?cance of our theoretical results, we provide a nontrivial example at the end.

keywords:

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*Corresponding author :benhadda.walid@gmail.com

†:m.elomari@usms.ma

‡:abderrazakassidi@gmail.com

§:a.elmfadel@usms.ma

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