Crina Grosan – Curriculum Vitae

Senior Lecturer
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Qualifications
PhD in Artificial Intelligence, Faculty of Mathematics and Computer Science, Babes-Bolyai University, Cluj-Napoca.
Thesis title: Multiobjective optimization using evolutionary algorithms, Distinction: Magna cum Laude
M.Sc. in Complex Analysis and Optimization, Faculty of Mathematics and Computer Science, Babes-Bolyai University, Cluj-Napoca
B.Sc. Faculty of Mathematics and Computer Science, Babes-Bolyai University, Cluj-Napoca

Research interests

My research interests are in the area of machine learning, optimisation, networks, and decision making. They include both theoretical and algorithmic development as well as applications for particular classes of problems, such as classification, prediction, estimation, clustering, data mining, and pattern finding. I have published three books and over 100 journal and conference articles. As per Google Scholar, I have an h-index of 36, with over 4,700 citations to my work.

Research grants

IntelliRehab - intelligent medical system with customised exercises for personalised home telerehabilitation, Innovate UK, 2016-2020
IPROCOM - The development of in silico process models for roll compaction", EU FP7 Marie Curie ITN, 2013-2016
Scientific computation and optimization for interdisciplinary applications, CNCSIS grant (Romania)
Nature's heuristics for knowledge discovery from very large databases. Applications in stock market modeling, intrusion detection, classification problems from medical domain, optimisation, CNCSIS grant (Romania)
New Evolutionary Optimization Techniques: Applications in crystalline structure detection and database interrogation", CNCSIS grant.

Recent publications

1. Sadawi, N, Miron, A., Ismail, W., Hussain, H., Grosan, C. Gesture Correctness Estimation with Deep Neural Networks and Rough Path Descriptors, IEEE International Conference on Data Mining, SSTDM Workshop, 2019
2. Olier, I., Sadawi, N., Bickerton, G.R., Vanschoren, J., Grosan, C., Soldatova, L., King, R., Meta-QSAR: a large-scale application of meta-learning to drug design and discovery, Machine Learning, 107(1), pp. 285-311, 2018
3. Li, M., Grosan, C.,Yang, C.,Liu, X.,Yao, X., Multi-Line Distance Minimization: A Visualized Many-Objective Test Problem Suite, IEEE Transactions on Evolutionary Computation, 22(1), pp. 61-78, 2018
4. Emary, E., Zawbaa, H.,Grosan, C., Experienced grey wolf optimizer through reinforcement learning and neural networks, IEEE Transactions on Neural Networks and Learning Systems, 29(3), pp. 681-694, 2018
5. 4 Zawbaa, H.M., Szlek, J., Grosan, C., Jachowicz, R., Mendyk, A., Computational Intelligence Modeling of the Macromolecules Release from PLGA Microspheres - Focus on Feature Selection PLOS One 11 (6), e0157610, 2016
6. Zawbaa, HM., Emary, E., Grosan, C., Feature Selection via Chaotic Antlion Optimization, PloS one 11 (3), e0150652, 2016
7. Olier, I., Grosan, C., Sadawi, N., Soldatova, L., King, R.D., Meta-QSAR: Learning How to Learn QSARs. MetaSel, PKDD/ECML, pp.104-105, 2015

Description of the research group

I am based in the Computer Science Department, College of Engineering, Design and Physical Sciences at Brunel University in London. The student awarded this scholarship will join my research group and will work collaboratively with me and the other researchers from the group interested in the same topic.

My research is channeled into two major and interlinked directions: fundamental machine learning and optimisation methodologies which concern the development of new algorithms to address open problems and challenges, and applications of machine learning and optimisation methods to solve real-world problems. I have extensively used and developed machine learning methods as well as ensembles or hybrids of these methods by combining them in various ways and for various applications. My research has materialised in several efficient artificial intelligent methods general enough to tackle problems in a connected data analysis environment: classification, clustering, prediction, optimisation, data mining, decision making, both in a static as well as in a dynamic environment.

My research group currently consists of 2 postdoctoral research fellows, 2 PhD students (a third one will start in April 2020) and one postgraduate research assistant.

One of my group's current research projects investigates the development of a personalized rehabilitation system using machine learning. The goal of this project is to motivate patients with disabilities to get better in a faster, easier and fun way. It applies artificial intelligence methods to a software that turns traditional physical therapy exercises into interactive applications, including video cogniexergames. This helps patients perform the right exercises, gives them incentives to progress and tracks not only when they have done the exercises, but how effectively they are doing them. It contributes towards improving patient's quality of life, while setting the standard for rehabilitative and long-term care through personalized technology.
The research is directed towards and tailored for patients with neurological disabilities (recovering from stroke, hemiparesis, tetra paresis, Parkinson's disease), with orthopedical problems (fractures, surgeries, musculotendinous disorders) as well as patients with age-related problem (arthritis, falls). The rehabilitation software includes a variety of exergames for developing upper limb coordination, improving upper limb and range of motion, reaching objects, speeding constrained movements, and many more. For all the conditions mentioned, exergames are a convenient form of physical exercise and are beginning to be employed in many rehabilitation domains. However, exercises are not individualised, and, moreover, are not really meant for a targeted condition, group age, etc.

This research is done in collaboration with an SME (MIRA Rehab), with The University of Manchester, and with a rehab centre and a Neurological Hospital in Malaysia (through funding received from Innovate UK).

The research fellows and the postgraduate research assistant from my group work on this topic, which is directly linked with the research project proposed here.

Description of the work to be carried out by the student (max. 1 page)

Project title: Experimental artificial intelligence for healthcare data

Human movement (or action or motion) recognition is a classical computer vision problem of identifying a certain movement from a set of available movements. A movement usually lasts from several seconds to a few minutes and its action is spatio-temporal (a sequence of frames or images in time). The data can be captured using motion sensor cameras and can be stored in a few formats, such as: colour or depth images; angles (represented in degrees) between different body segments; 3D skeleton points positions (represented in millimetres) of various body joints.

The scope of this research is, however, not to concentrate on movement recognition but on *movement correctness detection*. A binary classification problem in machine learning terms (determine whether a movement is correctly executed or not), this problem is actually much more complex than movement recognition, as we should first recognize the movement and then determine whether it is a correct or an incorrect execution of it.

In this research we will deal in particular, with data collected using the Kinect motion sensor camera and is further processed to store the skeleton joints positions.

The challenge is to develop a generic architecture composed of machine learning algorithms to produce high precision indications of human movement correctness.

There are three main aspects that could be investigated:

1. ***Investigate ways to consider the input data***

Each session recorded has a different number of frames because subjects perform movements at different speeds. In order to use deep neural network architectures, we have to normalize all sessions to a fixed number of frames. So far, we have experienced with two methods that achieve this: zero padding windowing with window size minimum number of frames. However, sometimes the difference between subjects can be really significant and both these methods generate loss of information. The plan is to investigate in a comparative manner the following input pre-processing options:

a) zero padding
b) windowing with window of size minimum number of frames
c) windowing with window of a given size
d) upsampling the shortest samples by duplicating uniformly selected time-points
e) subsampling the longer instances by removing time-points that are too close (distance wise, using a threshold) to the previous time-point.

2. ***Investigate the most appropriate machine learning methods***

From our previous experience with this problem, we have investigated the performance of three machine learning methods: convolutional neural networks, long short-term memory neural networks and a technique based on rough path theory to extract unique sequences (i.e. path signatures) from gesture data and to use them as inputs to classical classifiers such as RandomForest (RF) and k-Nearest Neighbor (kNN).
The plan to investigate this further and plan the following for this research:

a) experiment with filters of sizes other than one
b) include additional elements in the network architecture: Batch normalisation, dropout (before or after BN), residual blocks
c) investigate other methods of computing convolutions:
    i. Fast Fourier Transform algorithms
    ii. Winograd Minimal Filtering
    iii. Number Theoretic Transform (Fermat Number Transform)

3. ***Identify optimal ways to augment the data***

For several subjects, the number of correct vs incorrect repetitions is much larger. An option to balance the data is to use data augmentation techniques to generate synthetic data from each subject's actual data (from incorrect repetition data) so that the number of correct and incorrect repetitions is approximately the same for all subjects in all gestures.

Other information

We can arrange student accommodation in the student halls here at Brunel at a very convenient price compared with off-campus accommodation.

London is a very active city, with plenty of activities and attractions.