Operations Research
Recherche opérationnelle
(Org: **Bao Nguyen** and/et **Davide Spinello** (Ottawa))

DR. PETER DOBIAS, Defence Research and Development Canada
Non-equilibrium systems, fractals, and phase transitions

Despite the fact that simple equilibrium distributions, including Gaussian or exponential distributions, are commonly used to model many natural and socio-economic systems, it could be argued that many systems in nature as well as in society are in fact far from equilibrium and that the use of these distributions is not appropriate and can lead to underestimating risk of extreme events. In fact, observations suggest that many systems exhibit critical properties such as power law scaling of their size-frequency distribution, and complicated distributions. In this paper we describe the general characteristics of such systems, and then we present two examples, one from natural, and one from social systems. The first example looks at the earth's magnetosphere. The magnetospheric characteristics commonly exhibit scaling properties, internal correlations, and noise common to phase transitions. This fact indicates that despite the fact that the common analyses focus on specific triggers, it is the overall state of the system that really matters. This is consistent with a body of theoretical and experimental research in space physics. In the socio-economic domain a prominent example heavily studied over the last decade relates to asymmetric warfare and terrorism. Again, both of these types of violence exhibit scaling properties common to critical systems. If they are indeed behaving as non-equilibrium, critical, systems, this would have implications for both the trend interpretation and for predictive analysis. We will discuss a body of work comparing modelling and observations that support this notion.

PROF. JOANNA OLSZEWSKA, UWS, UK
Algorithms for Intelligent Vision Systems

Intelligent vision systems (IVS) are a set of interconnected hardware and/or software components which take digital image(s) as input data and process them by means of methods ranging from low- to high-level techniques/algorithms in order to extract meaningful information, which could be structured and organized into knowledge, and aid to the automatic understanding of the gathered visual data. Nowadays, IVS are present in a wide range of applications, ranging from autonomous vehicles to assisted-living devices; from rescue operations to video surveillance. These systems aim to get a higher autonomy as well as further levels of automated reasoning based on visual input and involves softwares integrating AI-based algorithms. Hence, the design of the new generation IVS is facing several challenges such as correctness and learnability as well as security and transparency. In particular, the choice of adequate algorithms for IVS is of prime importance. Indeed, these algorithms must be not only reliable and accurate, but also explainable and portable. Hence, this talk focuses on presenting efficient algorithms for the IVS dedicated to tasks such as the automated detection, recognition, and tracking of objects of interest.

PROF. LIAM PAULL, Université de Montréal
Training Robots in Simulators

One paradigm to building robotic agents is reinforcement learning. It is flexible and general. However, there are some particular challenges with respect to training RL agents on real physically embodied systems. For example: RL training tends to be quite innefficient and performing rollouts on a real robot system is expensive, real world environments don't automatically reset, and real world environments don't necessarily provide a reward signal to the agent explicitly. To overcome these challenges, training agents in simulators is appealing. However, the new problem becomes ensuring that an agent trained in a simulator generalizes to the real environment, the so-called sim2real problem. In this talk we will present two paradigms for tackling the sim2real, which we refer to as "Learn to Transfer" and "Learn to Generalize". We will also outline some future directions that we are pursuing in the Montreal Robotics and Embodied AI Lab (REAL) in this direction. Finally, I will also briefly describe our AI Driving Olympics project in connection to the problem of robotics benchmarking and "sim2real" transfer.

PROF. BAO UYEN, uOttawa/Defence R&D Canada

Stopping condition processes for multiple entities

In both natural and artificial systems there are many stochastic processes which require a stopping condition. Examples of such processes include flipping a coin until we get a head, drawing a card until a certain value is obtained, or imposing a lockdown until the number of infections is below desired threshold. In this talk, we present the derivation of a general stopping condition for multiple entities (e.g., multiple coins) each with a number of opportunities and a total number of trials. Then we provide some real life examples how these conditions work, such as the Shoot-Look-Shoot tactics in air defence engagements or the community lockdown policies currently used all over the world.

DR. GREG VAN BAVEL, Government of Canada

Prioritization and Pareto Efficient Sets: Non-dominated Sorting for Multiple-Criteria Decision Analysis

The prioritization of options occurs frequently at the Department of National Defence. In many cases, the prioritization effort is a response to a situation in which there are many options, but only enough resources to satisfy the requirements of a fraction of the options. The use of multiple criteria and a team of subject matter experts to evaluate the options against those criteria is a conventional way to prioritize many options. This report discusses a well-established method, called non-dominated sorting, that systematically processes multiple evaluations of multiple criteria and thereby organizes the many options into prioritized sets, which are eminently suitable for trade-of discussions and negotiations. By using simple examples and detailed demonstrations, this presentation takes a closer look at an old method. The development of visualizations aid the presentation of results from two actual cases. The real-world cases yield empirical evidence related to the practical utility of non-dominated sorting and entail recommendations regarding how decision analysts can make the most of the method in their own work.