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Programme > Programme détaillé

Lundi 10 juin 2024

Heures Événement

(+)

12:30 -
13:00 Accueil des participants - Accueil des participants13:00 -
13:15 Ouverture du Colloque GdR SOC2 2024 - Ouverture du Colloque GdR SOC2 2024

Calcul embarqué haute performance (INSA Toulouse - Amphi Riquet)

[Matthieu MARTEL \(Université de Perpignan\) : Matrix Computations: In Seek of Frugality](#)

Abstract: Frugal computing is becoming an important topic for environmental reasons. In this context, several techniques have been proposed to reduce the storage of scientific data by dedicated compression methods specially tailored for arrays of floating-point numbers. While these techniques are quite efficient to save memory, they introduce additional computations to compress and decompress data before processing them. In this article, we introduce a new lossy, fixed-rate compression technique for 2D-arrays of floating-point numbers which allows one to compute directly on the compressed data, without decompressing them. We obtain important speedups since less operations are needed to compute among the compressed data and since no decompression and re-compression is needed. More precisely, our technique makes it possible to perform basic linear algebra operations such as addition, multiplication by a constant among compressed matrices and dot product and matrix multiplication among partly uncompressed matrices. This work has been implemented into a tool named blaz and we present a comparison with the well-known compressor zfp in terms of execution-time and accuracy.

13:15 -
14:30 [Nicolas GAC \(Université Paris-Saclay, laboratoire SATIE\) : Dark-era : Dataflow Algorithm architecture co-design of SKA pipeline for Exascale Radio Astronomy](#)

Abstract: Le radiotélescope exascale Square Kilometre Array (SKA) a pour objectif de fournir des images à une précision et sensibilité inégalées. Cela nécessite le développement de méthodes de traitement nouvelles et des supercalculateurs aux exigences techniques élevées. Le pipeline Science Data Processor (SDP) chargé de produire les images multidimensionnelles du ciel devra exécuter en temps réel cette chaîne algorithmique complexe avec des données provenant des télescopes à un débit incroyable de plusieurs Tb/s et des possibilités de stockage limitées. Le SDP devra également être le plus vert possible avec une puissance électrique limitée à 1 MWatt pour 250 Pétaflops.

Le supercalculateur SDP sera basé sur un système HPC avec une architecture hétérogène : chaque noeud est constitué de CPUs associés à des architectures accélératrices de type GPU. Un défi crucial est d'évaluer les performances en temps et en énergie de nouveaux algorithmes de flux de données scientifiques complexes sur des infrastructures informatiques complexes non encore existantes. Dans ce contexte, le projet collaboratif ANR Dark-era vise à proposer des méthodes de co-conception efficaces et des outils de prototypage rapide s'appuyant sur des outils développés plus spécifiquement pour l'embarqué (PREESM) et les supercalculateurs homogènes (Simgrid).

14:30 -
15:30 Session Poster 1 et Pause café (INSA Toulouse - Jardin Amphi Riquet)15:30 -
16:45 Intelligence artificielle et systèmes embarqués (INSA Toulouse - Amphi Riquet)[Sébastien BORJA \(ARIBUS\) : Embedded Computation using SoC for Space Robotics](#)

Abstract: From an architecture standpoint, a robotic application is a delicate trade between “sense”, “think” and “act”. In other words any robotics stacks has to deal with perception, planning and control algorithms. From kinematics to dynamics models, applied mathematics is providing the necessary toolset to formulate the problems. However the required computation solvers might have to be adapted to the embedded constraints considerations. Whatever we are considering heavy computation on the fly or even at differed time, embedded platforms is mainly fitting with scarcer computation resources. In front of the classical heavy computation datacenter perspective, this is a complete paradigm shift.

This is even prominent considering the scope of use. Robots used in a manufacturing shopfloor on ground will probably be less constrained than orbital space manufacturing! How to cope for example with side effects linked to space radiation for electronics, when dealing with highly integrated chips? Accelerators based on FPGA and packaged in deeply integrated SoCs are a strong area of focus in these discussions. Last but not least, nobody can ignore today the rise of AI in such domains; however making it usable, provable, industrial is a journey by its own. From symbolic AI to data centric AI what are the key

Heures	Événement	(+)
	elements which might be fully embedded into hardware co-processing in nowadays architecture?	
	In that talk we are going to dig a bit on some questions around it (from the multiple one that are under study) :	
	• How far multi agent software stacks is contributing to optimize behavior planning (using behavior tree description), especially when dealing with space compliant software/hardware standard ? • How far can we integrate relevant mathematical operations in space grade electronics?	

We will consider these 2 questions in the frame of SoC deployment on space manufacturing robotics use cases.

[Patrick Gallinari \(ISIR - Sorbonne University\) - AI4Science: Physics-Aware Deep Learning for Modeling Dynamical Systems](#)

Abstract : Deep learning has recently gained traction in modeling complex physical processes across industrial and scientific fields such as environment, climate, health, biology, and engineering. This rapidly evolving interdisciplinary topic presents new challenges for machine learning. In this tutorial, I will introduce deep learning approaches for physics-aware machine learning, as part of the broader topic AI4Science, focusing on modeling dynamic physical systems ubiquitous in science. I will illustrate some of the main challenges of this topic, including incorporating physical priors in machine learning models, generalization issues for modeling physical processes, neural operators, and perspectives on foundation models for science. This will be illustrated with feature applications from different domains.

Méthodologies et outils (INSA Toulouse - Amphi Riquet)

[David Novo \(CR LIRMM\): Smart Data Movement across the Memory Hierarchy of Modern Computing Systems](#)

Abstract: Data storage and movement is a fundamental bottleneck in modern computing systems, greatly limiting their overall performance and energy efficiency. This presentation introduces two new techniques to achieve smarter data movement across the memory hierarchy. The first technique uses perceptron-based prediction to identify off-chip load requests using multiple program features. When the load is predicted to go off-chip, it issues a speculative request directly to the memory controller. As a result, the on-chip cache access latency is removed from the critical path when the prediction is correct. The second technique uses reinforcement learning for data placement in hybrid storage systems. These systems use multiple different storage devices to provide high and scalable storage capacity at high performance. Our new data placement technique observes different features of the running workload and the storage devices to make system-aware data placement decisions. Both techniques leverage machine learning algorithms to optimize data movement, significantly outperforming state-of-the-art solutions.

17:00 - [Claire Pagetti, \(DR ONERA\) : Certification of \(hybrid\) multi-core architectures](#)

18:15 **Abstract:** Multi-core processors have been available for many years on the market and they have been consequently embedded in safety-critical systems (e.g. automotive domain) for more than a decade. They have yet to break through in the avionic domain, one subject to certification. To allow the use of new technologies in a system, the applicant to certification must ensure safety properties and in particular its compliance with certification standards. The A(M)C AMC20-152A and AMC20-193 (formally CAST 32A) define objectives for the respective certification of hardware platforms and of multi-core processors. The PHYLOG project (2016 - 2020) proposed a methodology to facilitate the certification of multi-core processors in the avionic domain. Among the project outcomes, we will present the formal language PML that helps identify interferences within processors, and a stressing benchmarks methodology to help quantify the impact of said interferences.

Multi-core processors certification is now a reality and many applicants are working towards their certification. The emergence of Deep Neural Network (DNN) and machine learning-based applications paved the way for a new generation of hybrid hardware platforms. Hybrid platforms embed several cores and hardware accelerators in a small package. PHYLOG 2, as a follow up of PHYLOG, aims to prepare for the certification of these new platforms. We will present the advancement of the PHYLOG methodology extension for them.

18:30 -
20:30 Welcome Cocktail (INSA Toulouse - Jardin Amphi Riquet)

Mardi 11 juin 2024

Heures	Événement	(+)
08:30 - 09:00	Accueil des Participants - Accueil de participants	
09:00 - 10:15	<u>Circuits et Systèmes AMS & RF (INSA Toulouse - Amphi Riquet)</u>	

[Joris Pascal \(FHNW, Switzerland\) : Magnetometer network for shape detection: a new instrument for prosthetists and orthotists](#)

Abstract: To design personalized prostheses and orthoses certified prosthetists and orthotists (CPO) have been using for hundred years plaster casting to mold the patient's limb. In contrast to optical scanners which require a line of sight, plaster casting makes it possible to apply manual corrections to limbs with deformation and to obtain a 3D model of the corrected limb shape. However, plaster casting is a wet, cumbersome, inaccurate, and analog technique. The presented smart sock embeds a network of hundreds of magnetometer chips. Through the magnetic tracking of these magnetometers, a point cloud is obtained and subsequently processed by a morphing algorithm. The system delivers in five seconds the digital 3D model of the patient's foot, which can be seamlessly used to design a patient specific foot orthosis in a fully digital manner.

[Dominique Morche \(CEA-Leti, France\) : Analog to Feature Extraction Circuit for Low Power RF Signal Recognition](#)

Abstract: In this presentation, we propose an ultra-low power highly configurable analog/mixed-signal (AMS) processor as part of a smart RF signal detection and recognition system focusing on the ISM band. We first introduce the application motivation and then justify the choice of a feature attraction

Heures	Evénement	(+)
	architecture. The analog feature extraction approach reduces power consumption at both circuit and system level with dynamic range and data rate reduction through smart feature selection. The implemented high configurability of the analog circuits enables detection and recognition of various signal types across a large variety of spectrum conditions. At the end, a comparison with state of the art will be given. The proposed system achieves state-of-the-art accuracy with sub-mW power consumption.	
10:15 - 11:15	Session Poster 2 et Pause café (INSA Toulouse - Jardin Amphi Riquet)	
	<u>Systèmes Connectés pour les Transitions (INSA Toulouse - Amphi Riquet)</u>	
	Nicolas Bideau (Université Rennes 2 / M2S) : Capteurs embarqués et IA au service de l'accompagnement scientifique de la haute performance sportive : Focus sur l'analyse de mouvements cycliques	
11:15 - 12:30	Abstract: L'analyse biomécanique constitue un axe central pour l'optimisation de la performance sportive, ce qui implique des collectes de données régulières et quantifiables en situation réelle d'exercice. A ce titre, le développement de capteurs embarqués pour analyser le geste sportif a été considérablement amélioré grâce aux avancées technologiques. Par ailleurs, les approches d'intelligence artificielle permettent de potentialiser l'usage des capteurs embarqués pour des retours rapides en cohérence avec les attentes du sport de haut-niveau. Nous présenterons ici des travaux menés dans le cadre de l'accompagnement scientifique à la performance dans l'optique des Jeux Olympiques 2024. Une attention particulière sera accordée à la combinaison de l'IA et des centrales inertielles pour l'évaluation du mouvement ainsi que sur des cas d'usages intégrant la régulation des variables biomécaniques pour l'optimisation du geste sur des sports cycliques. On s'attachera à montrer les enjeux majeurs autour la sélection des capteurs et l'acceptabilité auprès des populations sportives de haut-niveau, de la calibration capteur-à-segment et de l'automatisation des processus d'analyse pour des évaluations en routine à l'entraînement et en compétition.	
	Christian Bergaud (LAAS-CNRS) : Electrodes implantables : enjeux et perspectives	
	Abstract : Les électrodes implantables sont des dispositifs médicaux utilisés pour stimuler ou enregistrer l'activité électrique dans des tissus biologiques, notamment le cerveau, le cœur et les muscles. Elles jouent un rôle crucial dans le traitement de diverses pathologies comme la maladie de Parkinson, l'épilepsie et les troubles cardiaques. Les principaux enjeux incluent la biocompatibilité, la miniaturisation, la stabilité à long terme en réduisant la réponse immunitaire. Les perspectives futures se concentrent sur l'amélioration des matériaux pour réduire l'inflammation, le développement de technologies sans fil pour faciliter les implantations et l'intégration de systèmes d'intelligence artificielle pour optimiser les performances et les traitements thérapeutiques.	
12:30 - 14:00	Déjeuner (INSA Toulouse - Jardin Amphi Riquet)	
14:00 - 15:30	Club des partenaires (INSA Toulouse - Amphi Riquet) Remise des prix Concours RISC V (INSA Toulouse - Amphi Riquet)	
15:30 - 16:30	Session Poster Laboratoires et Pause café (INSA Toulouse - Jardin Amphi Riquet)	
16:00 - 18:00	TP Installation Plateforme RISC V (INSA Toulouse - GEI 109 & GEI 111)	
	Assemblée Générale GdR SoC (INSA Toulouse - Amphi Riquet)	
16:30-18:00	16h30-17h Agence de Programme ASIC (C. Maneux, J.P. Bourgoïn) : du composant aux systèmes et infrastructures numériques 17h-17h30 Intervention DAS CNRS Sciences informatiques (A. Histace) 17h30-17h45 Chantiers SOC2 (I. O'Connor, S. Pillement) 17h45-18h Questions diverses / échange libre	
19:30 - 23:00	Dîner (Hotel Dieu - Toulouse)	

Mercredi 12 juin 2024

Heures	Evénement	(+)
08:30 - 09:00	Accueil des Participants - Accueil des Participants	
09:00 - 10:15		

Systèmes robustes fiables et sécurisés (INSA Toulouse - Amphi Riquet)[Leopold Van Brandt \(UC Louvain\) : Prédiction des transitions d'état aléatoires dans les circuits électroniques bistables](#)

Abstract: Les systèmes autonomes bistables sont omniprésents dans de nombreux domaines scientifiques. Lorsque l'intensité du bruit intrinsèque est importante, ces systèmes présentent des transitions stochastiques d'un état métastable à un autre. Dans les mémoires électroniques bistables, telles que les cellules SRAM utilisées pour le stockage temporaire de données, ces transitions sont appelées bit flips, des erreurs se produisant en cours de rétention. Celles-ci peuvent être simulées numériquement dans le domaine temporel façon Monte-Carlo, toutefois à un coût calcul élevé. Ce constat motive une approche semi-analytique, reposant sur un modèle stochastique du circuit non-linéaire caractérisable à moindre coût par des simulations SPICE déterministes. Nous montrons que les formules analytiques requérant une approximation petit signal autour du point fixe stable de la dynamique de la cellule SRAM sont imprécises. Puisant dans le domaine de la chimie, nous proposons plutôt une formule d'Eyring-Kramers, laquelle peut être étendue afin de tenir compte d'une variance de bruit évoluant avec l'état du circuit. Les premiers essais numériques sur des cellules SRAM affectées par de sévères variations de fabrication suggèrent que l'ordre de grandeur du temps moyen avant défaillance est correctement prédit. Cela laisse espérer, à terme, l'émergence d'une méthodologie rigoureuse et systématique, à la fois précise et peu coûteuse, d'évaluation de la fiabilité des SRAM.

[Luigi Dilillo \(Université de Montpellier - IES\) : Electronics facing radiation harsh environment](#)

Abstract: The effects of radiation on electronic devices have been studied since 70s when critical errors were caused by cosmic ions affecting space probes of the Pioneer programs and the Voyager. In this field, research includes unknowns for almost every new device, technology node size, and technical development. Furthermore, it is always relevant and necessary to study the impact of radiation effects in today's devices. When designing electronic devices, the consideration of radiation effects is fundamental for the applications in its specific operational environment. For instance, in avionics systems, these effects are extensively studied to ensure the high reliability of the system components and provide the required insight for important design decisions. As the technology nodes get smaller, the devices more integrated and complex, testing them for radiation-induced effects become even more important. This procedure plays a crucial role in understanding the weakness of each technology, its failures mechanisms, and the mitigation techniques that can be applied. Relevant radiation effects might differ when considering different node sizes, for instance, Single-Event Effects (SEEs) are due to energetic particles passing through the semiconductor material transferring their energy through Coulombic interactions and transistor size matters to establish the critical deposited charge able to generate faults. Besides SEEs, radiation effects include Total Ionizing Dose (TID), Displacement Damage (DD). TID and DD are cumulative effects caused by the accumulation of ionizing radiation resulting in a long-term degradation of the device parameters, e.g., increase of the leakage current and shift of the transistor threshold voltage. Besides the fact that ionizing radiation may induce effects of different components, several works have shown that memories devices are one of the highest contributors to soft errors in systems. Furthermore, due to its nature, memories are capable of storing radiation-induced errors, e.g., Single-Bit and Multiple bit Upsets (SBUs and MBUs), making this kind of device the best candidate for studying soft errors. Other complex devices like microcontrollers as well as systems, in general, require a large effort to find valuable information on the actual inner structures that are more sensitive to radiation and which are the actual fault mechanisms and propagation paths.

10:15 - Session Poster 3 et Pause café (INSA Toulouse - Jardin Amphi Riquet)
11:15

Technologies du futur (INSA Toulouse - Amphi Riquet)

[Liza Herrera Diez \(C2N - Université Paris Saclay\) : Magneto-Ionics: advancing non-volatile control of magnetic properties for neuromorphic applications](#)

Abstract : The exploration of magnetic property manipulation through ionic motion in ferromagnetic/oxide structures has emerged as a promising avenue for non-volatile control of magnetism in spintronics devices. This concept unlocks new possibilities, such as the development of reconfigurable multistate memories and the incorporation of cumulative gate effects. Inspired by memristor technologies, oxygen-based magneto-ionics stands out as an advanced framework for influencing magnetic properties through ionics.

In this presentation I will provide an overview of this emerging field, and a description of the underlying physical-chemical mechanisms at play. I will also present our work on CoFeB/oxide systems, particularly Ta/CoFeB/HfO₂, where ionic gating induces the migration of oxygen-rich species within the stack. This migration results in distinct magneto-ionic regimes characterised by varying degrees of oxygen content, thereby allowing precise control over the oxidation state of magnetic layers and their magnetic properties. In this context, I will show our recent efforts towards designing synaptic elements based on Ta/CoFeB/HfO₂ magneto-ionic nano-devices and discuss their potential as a new generation of neuromorphic hardware.

11:15 -
12:30

[Guilhem Larrieu \(LAAS-CNRS\) : 3D Nano-Device Architecture for Frugal AI](#)

Abstract : Artificial Intelligence is extensively used for various learning and classification tasks, like facial recognition and biological signals classification, resulting in a significant increase in computing power demands and associated energy costs. This necessitates the exploration of energy-efficient alternatives. Neuromorphic systems, inspired by the nervous system, enable robust, autonomous, and power-efficient information processing through highly parallel architecture, contrasting with the limitations of conventional von Neumann architecture in fully leveraging parallelism and addressing inefficiencies in processing speed and energy consumption due to their sequential data processing and shared memory architecture. In this context, we will discuss new integration opportunities at the hardware level aimed at bridging the gap between memory and logic, particularly in the context of ultra-scaled 3D transistor architectures. To further harness the potential of biological intelligence, with its remarkable energy efficiency, the direct utilization of biological neurons, facilitated by bidirectional hybrid systems and biologically realistic AI algorithms, offers promising avenues. Lastly, we will explore novel pathways for possibly performing edge computing tasks utilizing biological neurons for low-power computing solutions.

12:30 - Déjeuner (INSA Toulouse - Jardin Amphi Riquet)
13:30
13:30 - Clôture du Colloque - Clôture du Colloque
14:00