ÉCOLE DOCTORALE
SCIENCES DE LA TERRE ET DE L'ENVIRONNEMENT ET PHYSIQUE DE L'UNIVERS, PARIS

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Titre du sujet : Understanding Seismic Signals of Dense Granular Avalanches: Unveiling Dynamics and Patterns

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Développement du sujet : (Maximum 2 pages)

Rapid flows of dense granular avalanches are a ubiquitous natural occurrence, particularly prevalent in mountainous regions around the globe. These mass movements, characterized by their potential for catastrophic consequences, have prompted extensive research endeavors spanning various methodologies, including field measurements, laboratory experiments, and theoretical advancements. Over the past 15 years, there has been a notable surge in interest directed towards investigating the seismic signals generated by these geophysical events. This exploration has yielded invaluable insights into their dynamics, shedding light on critical aspects such as the relationship between mass inertia and seismic energy, as well as the correlation between center of mass displacement and inverted forces. Recent laboratory experiments have further accentuated the significance of scaling with granular inertia and the high-frequency content of seismic signals. However, fundamental aspects of their dynamics, particularly regarding the scaling between long- period and high-frequency content, remain elusive.

The thesis project outlined herein aims to bridge these knowledge gaps by employing a multifaceted approach that integrates advanced seismic signal analysis techniques with cutting-edge methodologies. This includes the application of deep signal processing, dimensionality reduction, and clustering techniques coupled with structure, dynamics, and functions of complex networks. Leveraging physically-based artificial intelligence (AI) training, the project seeks to unravel the intricate, highly-dimensional properties inherent in seismic signals associated with dense granular avalanches. The primary objectives of the project are twofold: firstly, to conduct comprehensive data exploration to discern whether general patterns emerge, and secondly, to reconcile these emergent patterns with the underlying physics of individual events. This reconciliation will draw upon insights gleaned from numerical modeling, field observations, and remote-sensing data (Figure 1). Ultimatly, the combine approach will offers a new avenue for physically based AI inference on common caracteristics and specific features.

By elucidating generic features from event-specific characteristics, the project endeavors to establish a novel framework for comprehending the seismic signals associated with dense granular avalanches. Such a framework holds the potential to unlock fresh insights into the dynamics of these catastrophic events, paving the way for the development of new tools for their monitoring and early warning systems.

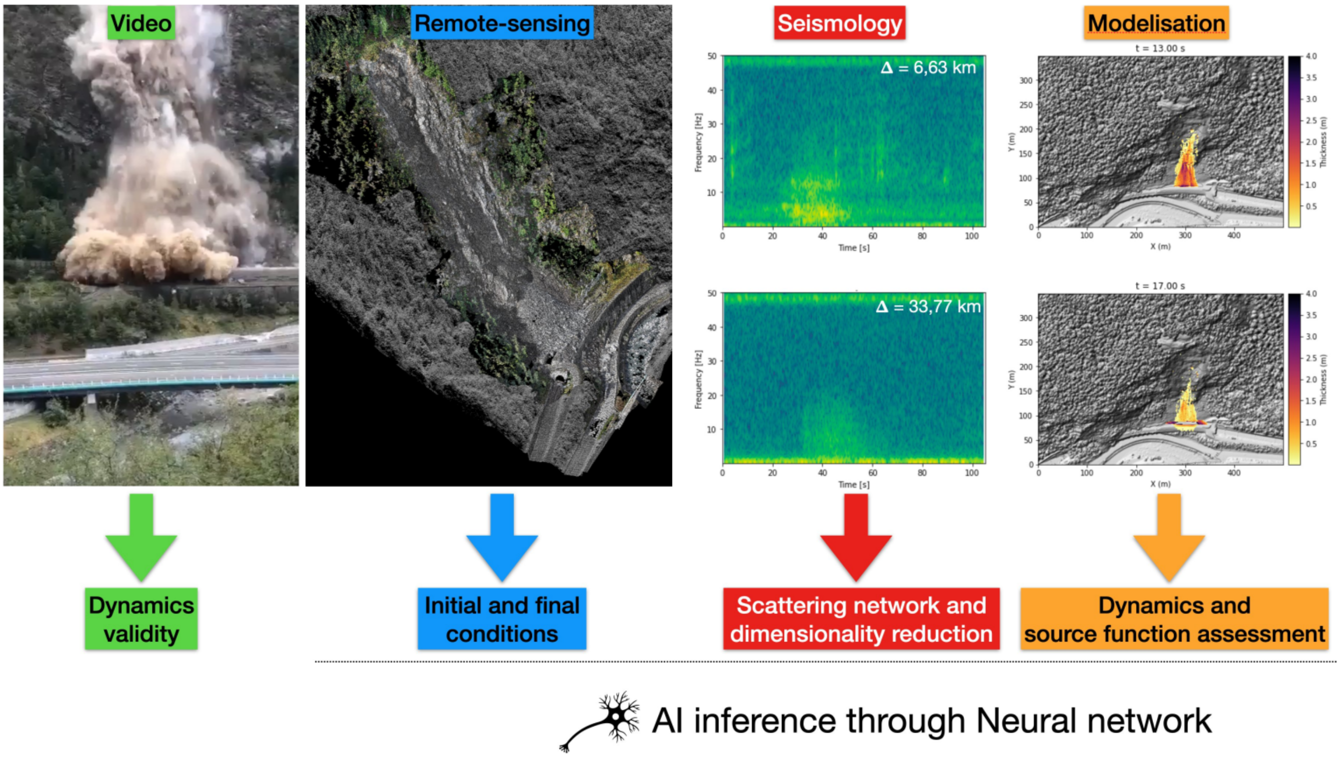

Figure 1: Thesis framework including available records from video (when available), remote-sensing (e.g., dyachronic LiDAR scans), seismology from networks, and numerical modelling to AI inference.

The ideal PhD candidate for this project should possess a robust background in physics, geophysics, applied mathematics or engineering, coupled with a keen interest in data science and its application in geophysics. Proficiency in programming is essential, as is a solid understanding of signal processing and machine learning techniques.