

# Systolic Array-Based Accelerator for Multi-Precision Multi-Arithmetic Types

## Problem:

Systolic arrays offer exceptional efficiency when it comes to performing matrix multiplication and are considered a prominent architecture in contemporary deep learning accelerators. Recent advancements in systolic arrays applied to Transformer models have showcased significant breakthroughs in the domains of natural language processing (NLP) and machine translation.

In this project, our focus lies in the development of a generalized version of the systolic array, capable of accommodating different levels of precision and arithmetic types. This project is aimed at supporting future research in related fields.

## Project Objective:

The primary aim of this project is to design and implement a systolic array-based accelerator capable of supporting convolutional neural networks using multi-precision and different arithmetic types numbers. This accelerator will utilize MLIR (Multi-Level Intermediate Representation) to generate instructions tailored for the hardware. Subsequently, this hardware component will be integrated into MASE as one of its hardware backend libraries.

## Here is a rough project timeline:

- **Oct - Nov:** Conduct research on systolic array-based accelerators and familiarize yourself with MLIR.
- **Nov - Dec:** Develop the systolic array-based accelerator and validate its functionality.
- **Jan - Feb:** Integrate the accelerator with MLIR. Create a custom dialect in MLIR that accurately represents the instructions, operations, and behaviors specific to

your hardware block.

- **Feb - March:** Merge the accelerator with MASE and conduct thorough testing with Convolutional Neural Networks (CNNs).
- **March - Jan:** Extend the project to include multi-precision and multi-arithmetic types, following a similar development and integration process.

It is important to note that this proposal is exclusively affiliated with Imperial College London and does not require any specialized equipment or external funding. This project has already been discussed with Dr. Aaron Zhao, who has expressed willingness to supervise and provide guidance throughout its duration.