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Towards Compositional and Generative Tensor Optimizations
Adilla Susungi, Norman A. Rink, Jerónimo Castrillón, Immo Huismann, Albert Cohen, Claude Tadonki, Jörg Stiller and Jochen Fröhlich

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Loop characteristics:
- 3 to 4 dimensions nesting
- Few iterations per dimension (e.g., 17 or 33 iterations)

Type of computations:
- Tensor contractions
- Outer products
- Element-wise multiplications
- Computations on each element of a structured mesh

Inverse Helmholtz
\[ t_{ijk} = \sum_{l,m,n} A_{klm}^T \cdot A_{jmn}^T \cdot w_{lmi} \]
\[ p_{ijk} = D_{ijk} \cdot t_{ijk} \]
\[ v_{ijk} = \sum_{l,m,n} A_{klm} \cdot A_{jmn}^T \cdot p_{lmi} \]

Tensor Optimization Frameworks

Domain-specific expressivity
Flexible/Adaptive optimization heuristics
Hidden and/or rigid optimization heuristics

Flexible/Adaptive
Optimizing CFD Kernels with Existing Tools

Several limitations
- Few opportunities for adaptations
- Unadapted constructs
- Limited expressivity

Chill
- Pluto
- TensorFlow
- TVM
- Tensor Contraction Engine
- Numpy
- Tensor Algebra Compiler

Should we create yet another domain-specific solution?

Intermediate Language

- Modular constructs
- First-class citizens: Arrays
- Tensor operators
- Loop iterators
- Transformations

Envisioned Tool

Meta-programming
Iterative search

Inverse Helmholtz by Example

Example of assessment: Different heuristics of loop interchanges (+ parallelization)

Future Work

- Applications to other domains
- Syntax refinement
- Formal semantics

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