Eigen Metting – Short Intro
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Overview

- What is Eigen all about?
- Eigen and Expression Templates
- Vectorization within Eigen
- Future Topics

What is Eigen all about?

- Linear algebra
- Matrix and vector operations
  - Fixed and dynamic size objects
  - Dense and sparse matrices
- Array operations
  - Offer component wise operations
  - Seamless conversion between matrix/vector and array
- Offers various decompositions
  - LU, Cholesky, QR, SVD, Eigenvalue, Schur, ...
- All algebraic operations are based on expressions templates
- All algorithms make use of vectorization
  - Eigen is not yet utilizing SMD - currently it‘s SIMD only

Eigen and Expression Templates

- Where do they occur?
  - All over the place ...
  - All algebraic expressions are implemented based on expression templates
- What are expressions templates?
  - Placeholders for algorithms and expressions
- What is the intent?
  - Lazy evaluation, i.e. deferred evaluation or execution
  - Reduces unwanted temporaries in long expressions
  - Combine concise notation and efficiency
- ... at the core level they are slightly complicated and hard-to-read

Vectorization within Eigen

- Generalized packet access of matrices and vectors
- Basic mathematical operations are specialized
  - i.e. seperate implementations for scalar and packet types
  - ei_padd, ei_psub, ei_pmul, etc.
- Specializations of special functions
  - ei_plog, ei_pexp, ei_psin, etc.
- All algorithms offer vectorized paths
  - Chosen at compile time
- Vectorization requires special alignment
  - Heap alignment is handled by Eigen‘s own allocation wrappers
  - Stack allocations are handled by compiler specific keywords
  - Objects holding Eigen types requiring alignment need special care

Future Topics

- Currently we are heading towards version 3.0
  - Fixing unstable API sections
  - Improving performance
  - Improving decompositions
- SSE4 and beyond
- SMD level parallelization
  - OpenMP vs. manual parallelization
- How will C++1x affect Eigen? Will it at all?