A Machine Learning Framework for Large-Scale Weather and Climate Prediction

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BoF: Achieving Performance on Large-Scale Intel Xeon-Based Systems

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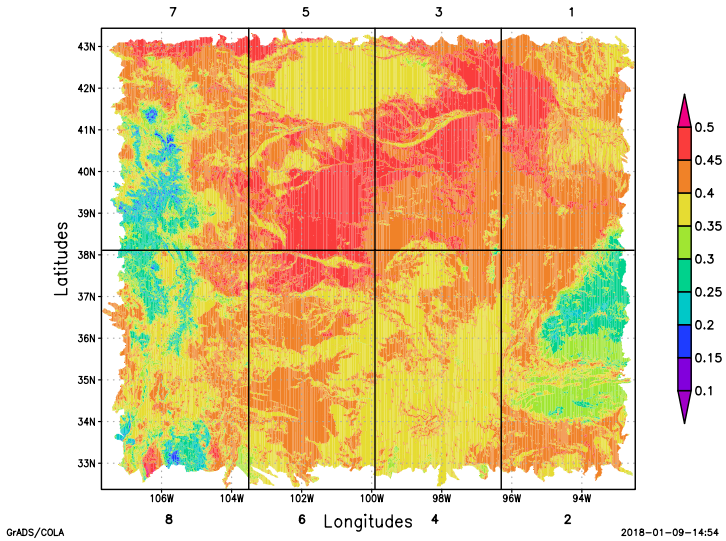
Climate/Weather Forecasting

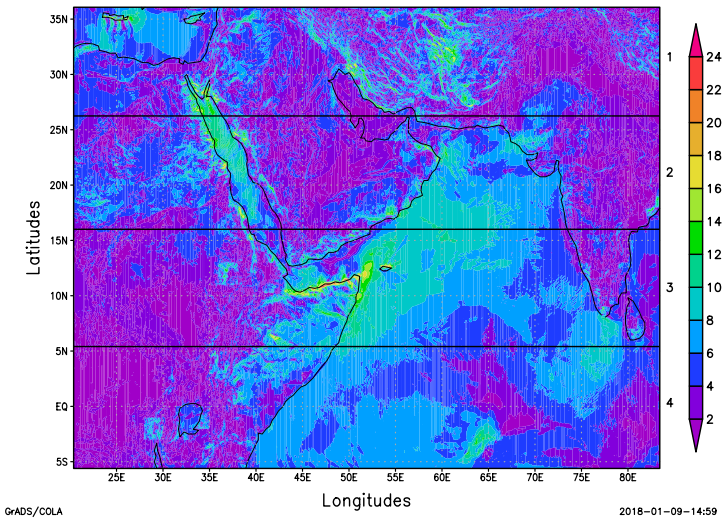
- Computational statistics: multivariate large spatial data sets in climate/weather modeling:

$$\ell(\boldsymbol{\theta}) = -\frac{1}{2}\mathbf{Z}^T\Sigma^{-1}(\boldsymbol{\theta})\mathbf{Z} - \frac{1}{2}\log|\Sigma(\boldsymbol{\theta})|$$

(a) Problem Definition.



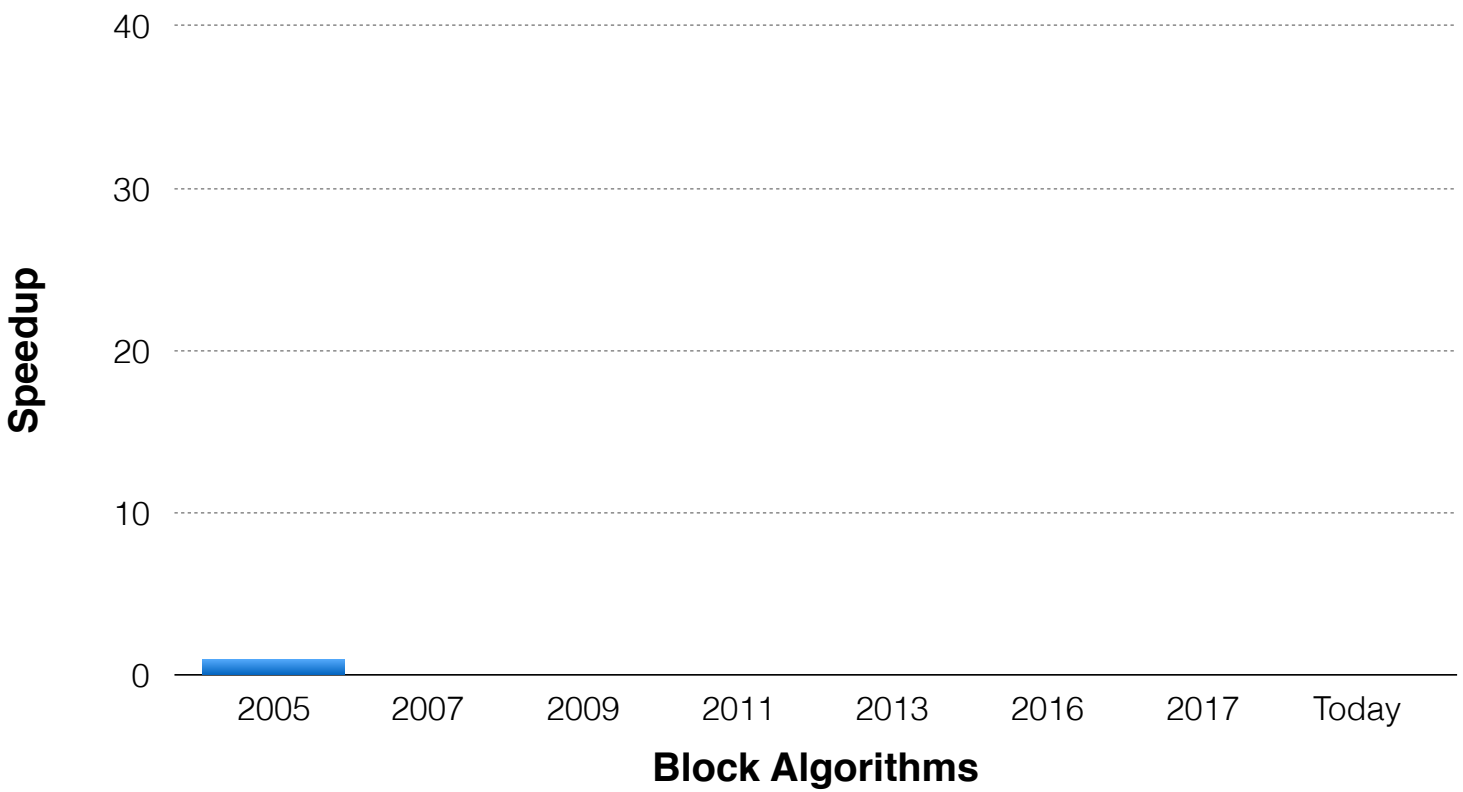
(b) Soil moisture.



(c) Wind speed.

w/ Y. Sun and M. Genton

Performance Evolution of Dense Cholesky Factorization



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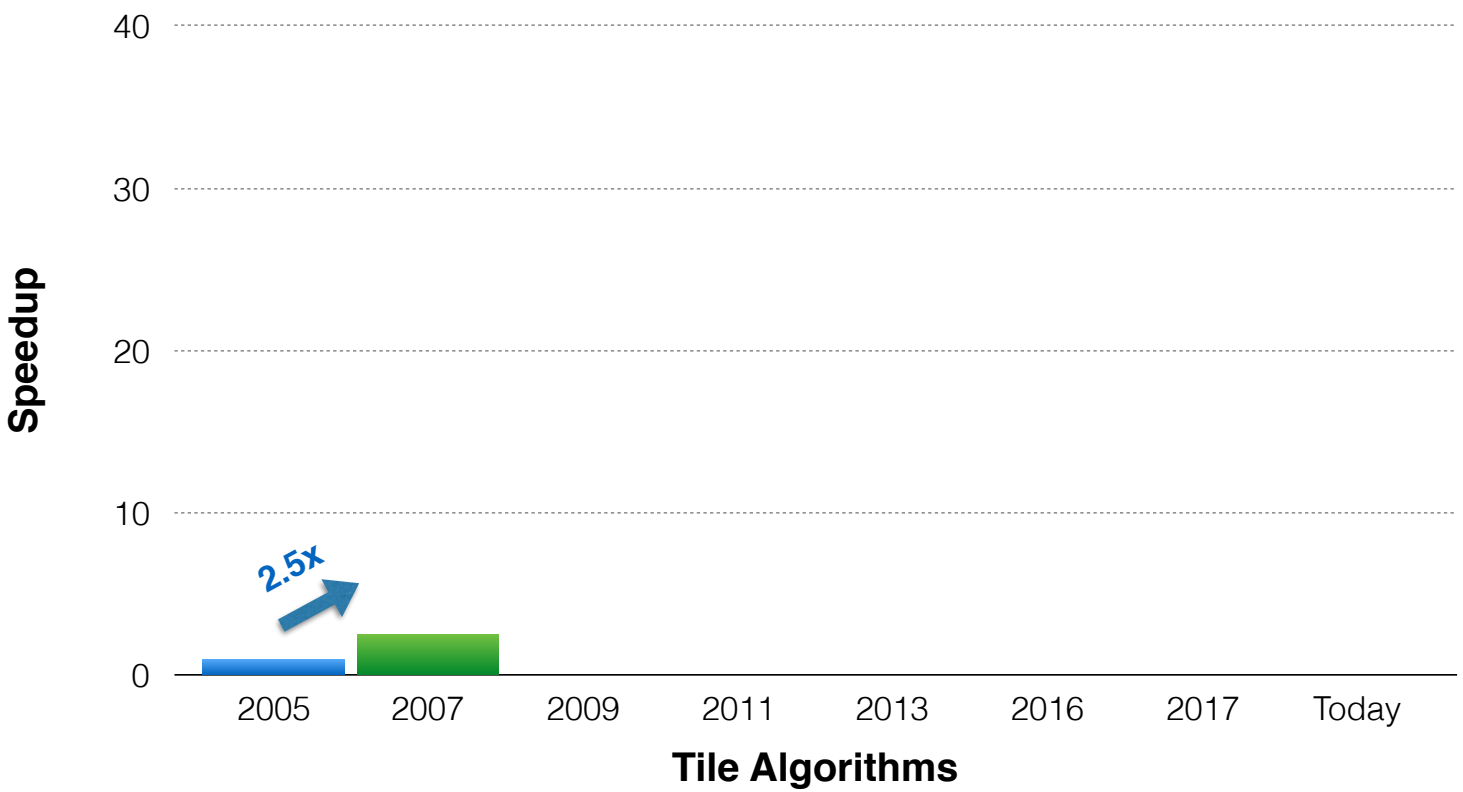

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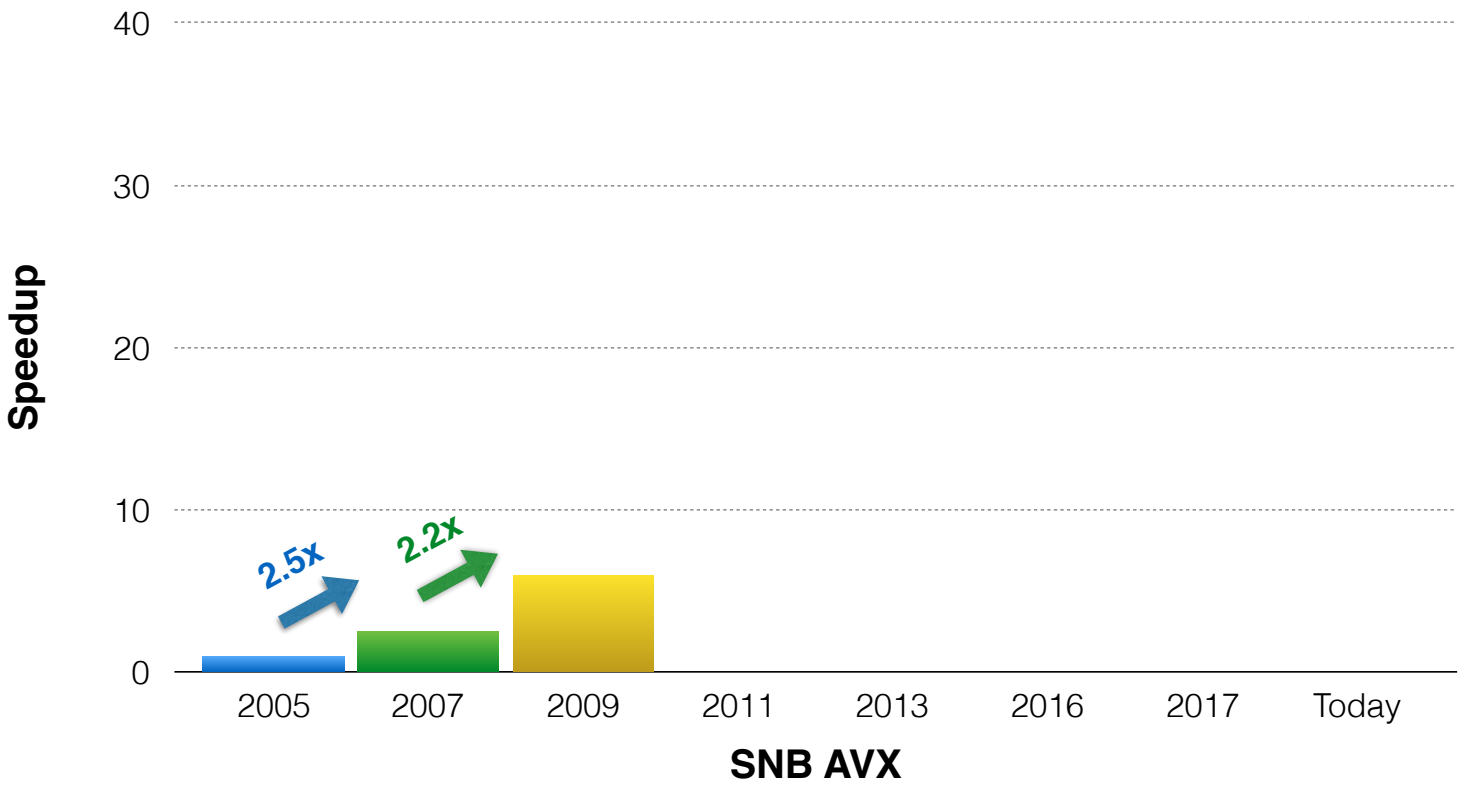

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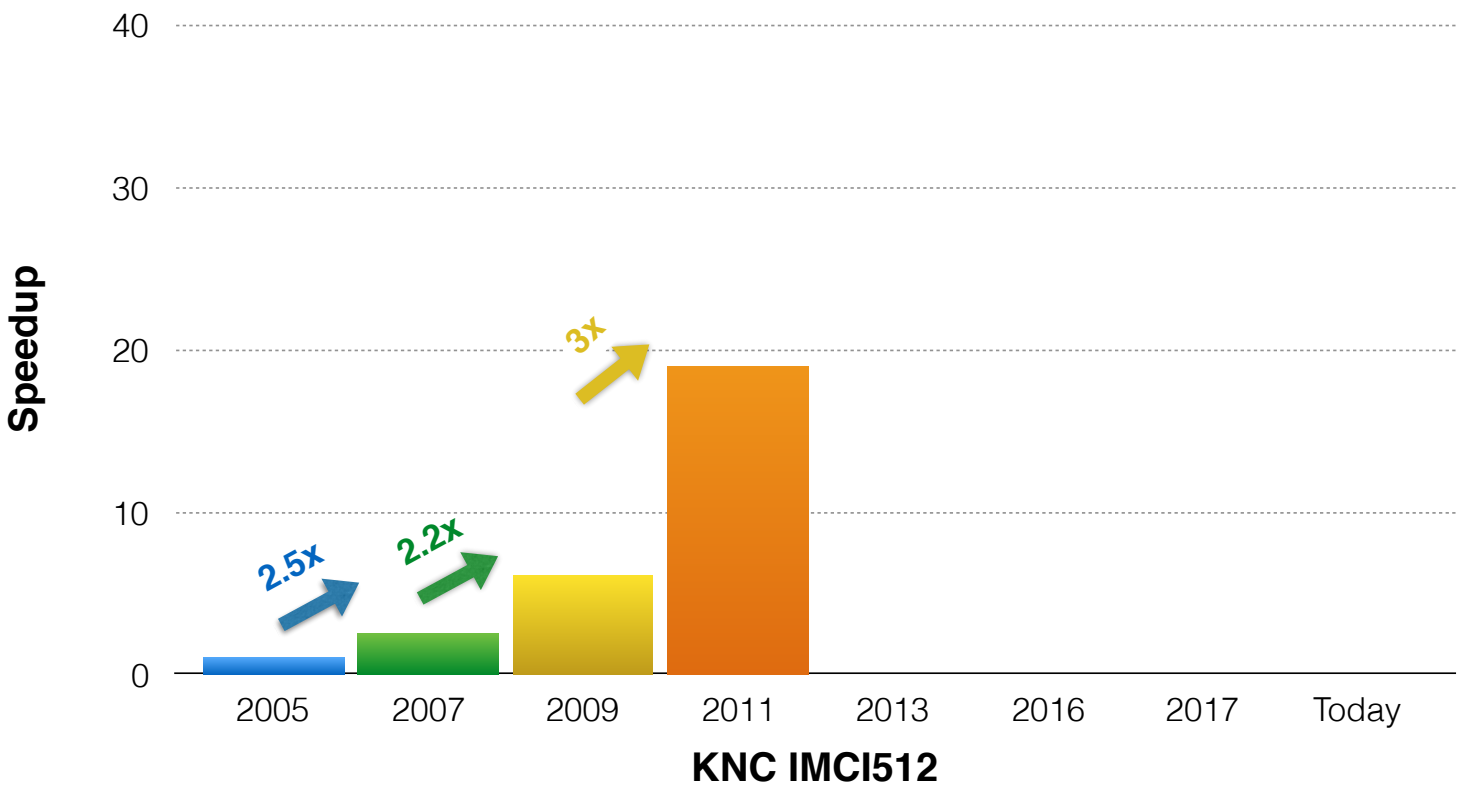

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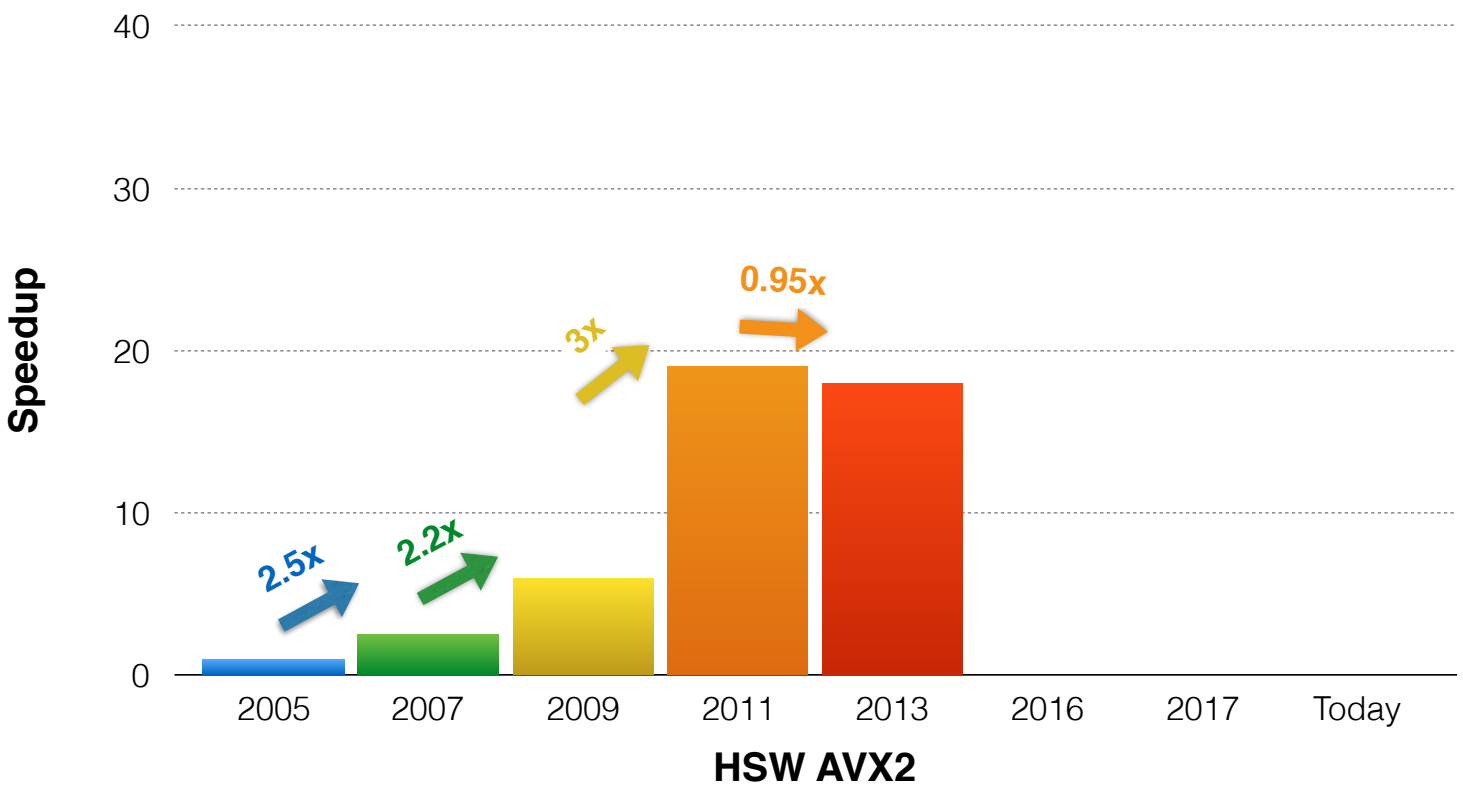

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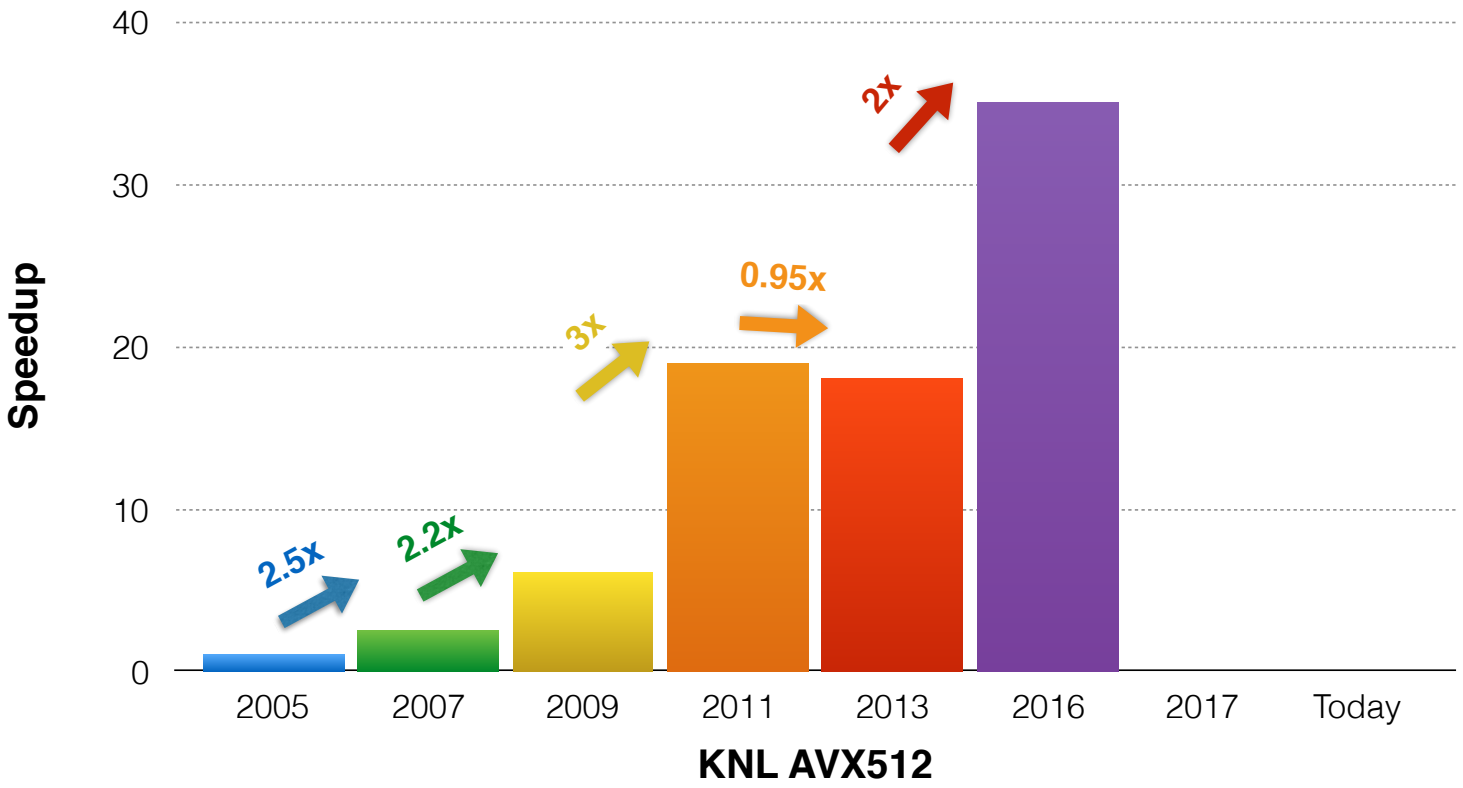

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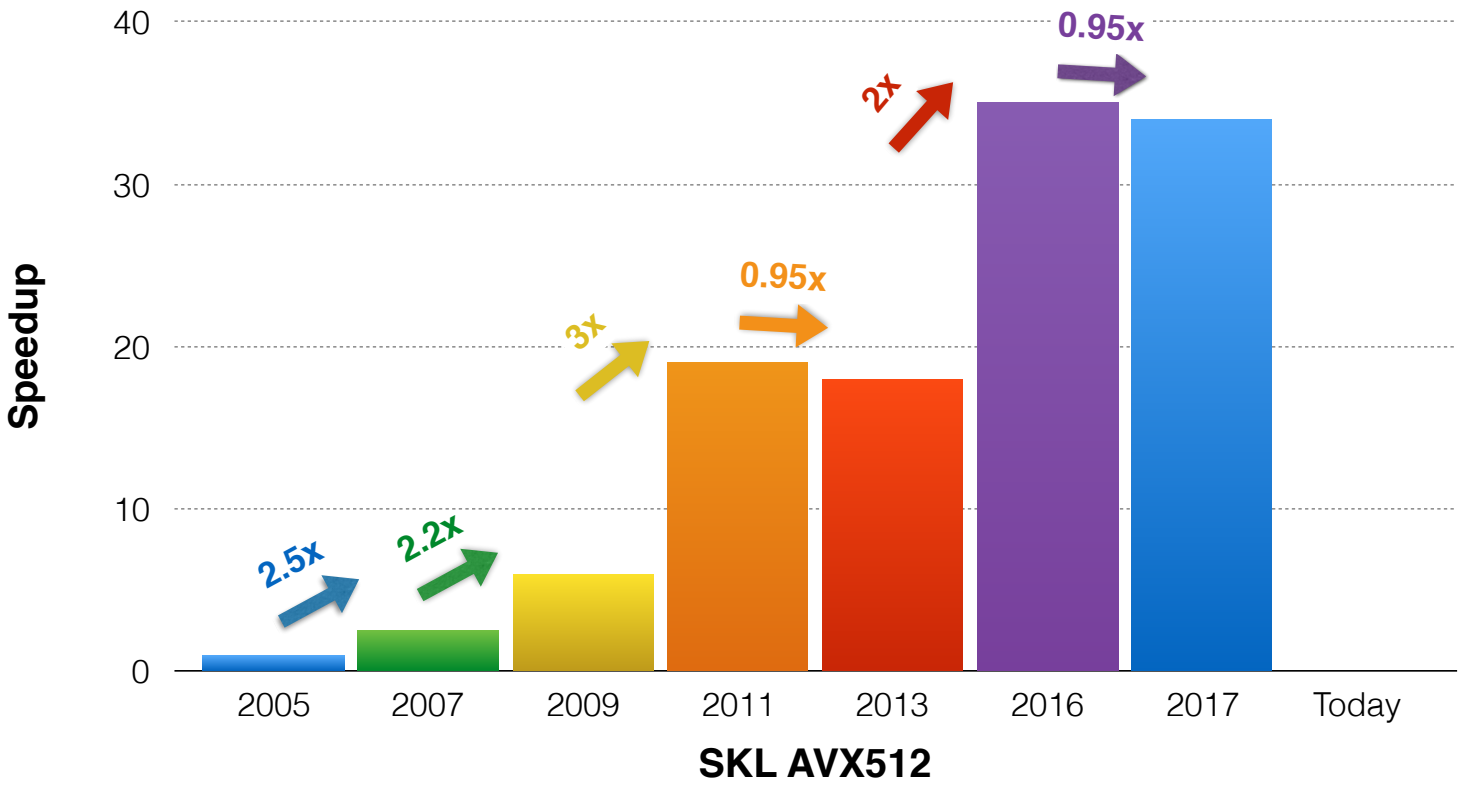

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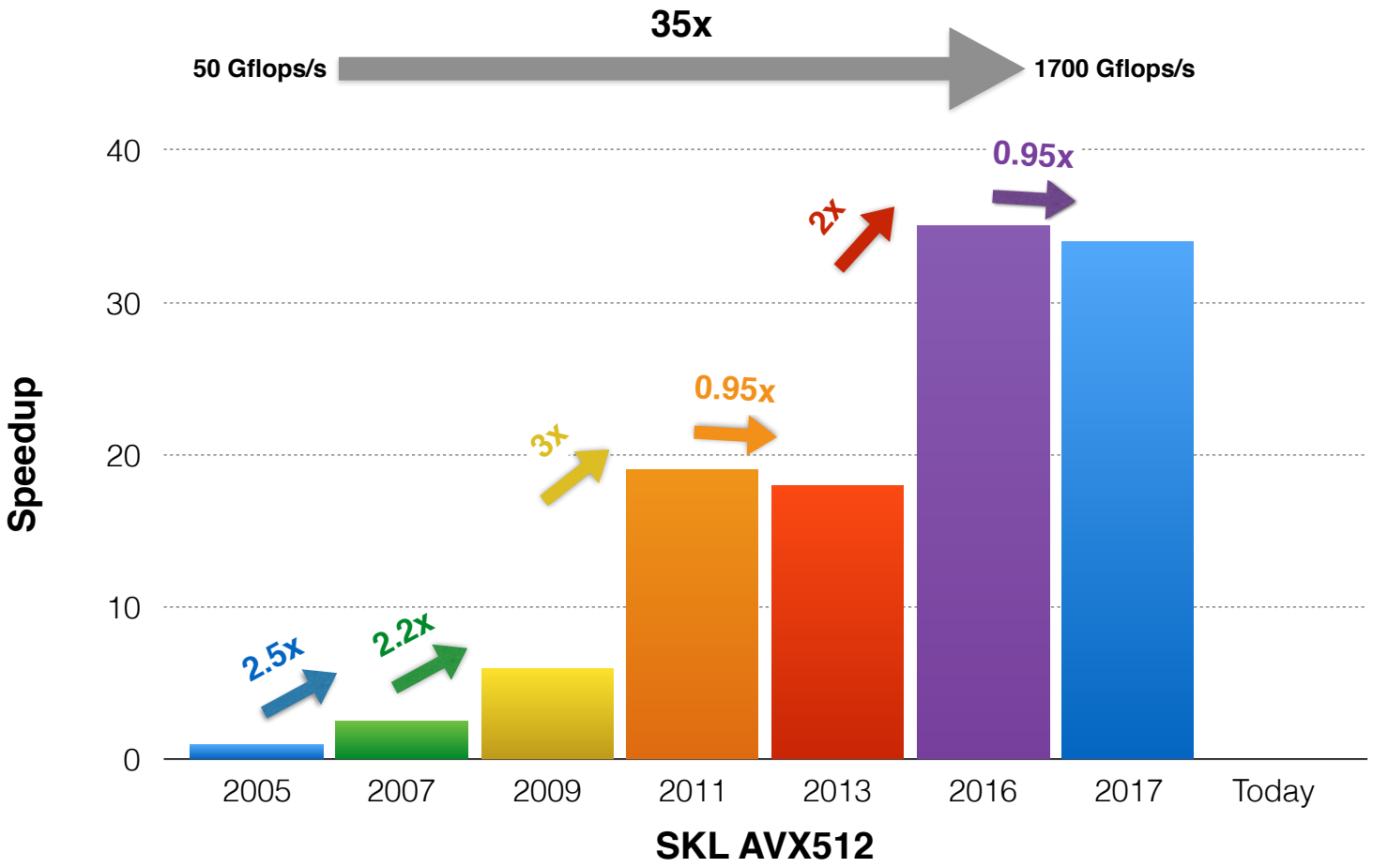
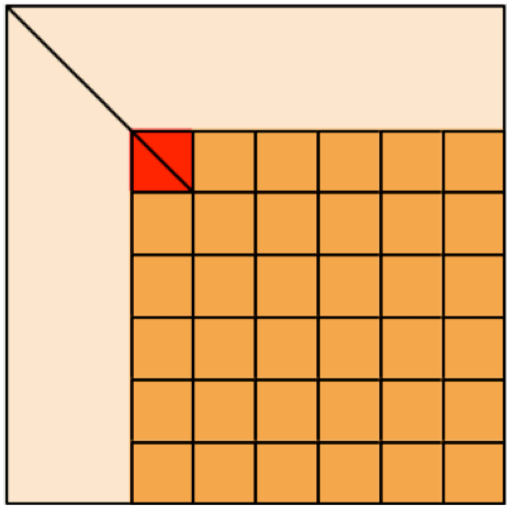


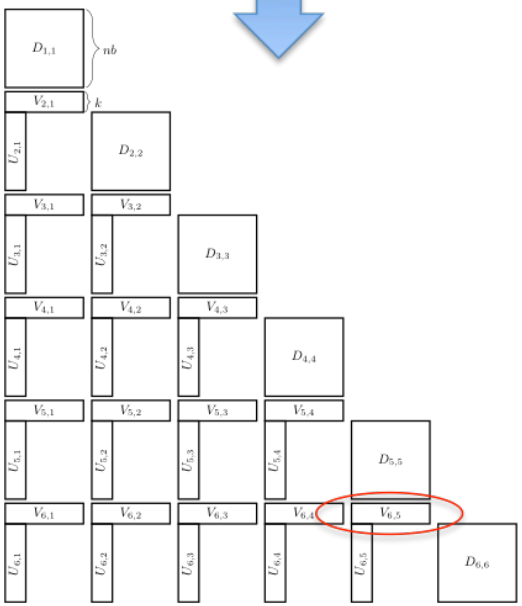
Performance Evolution of Dense Cholesky Factorization

Dense Linear Algebra Renaissance

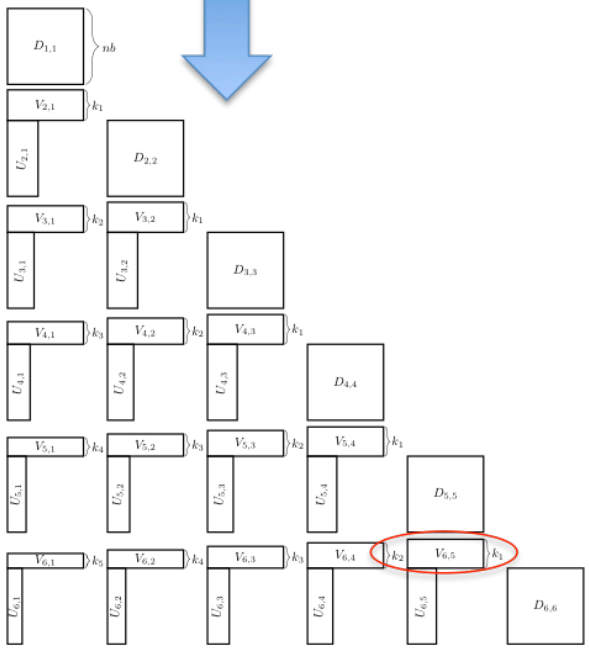


dense tiles
Cholesky: O(n³)

tile low rank
Cholesky: O(kn²)



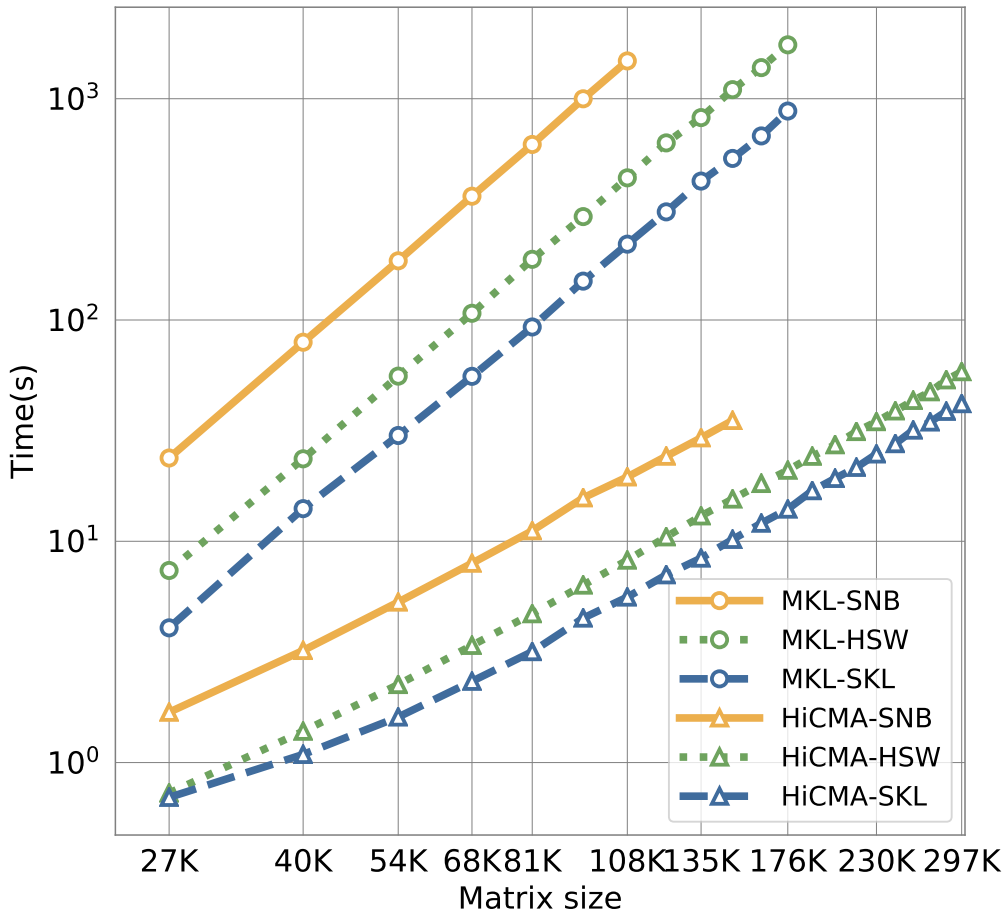
Fixed ranks
Preconditioners
Performance oriented



Fixed accuracy
Variable ranks
Dense/Sparse Direct Solvers

HiCMA Vs Intel MKL on Shared-Memory Systems

- Geospatial statistic w/ square exp. kernel and acc=1e-8



Performance Evolution of Dense Cholesky Factorization

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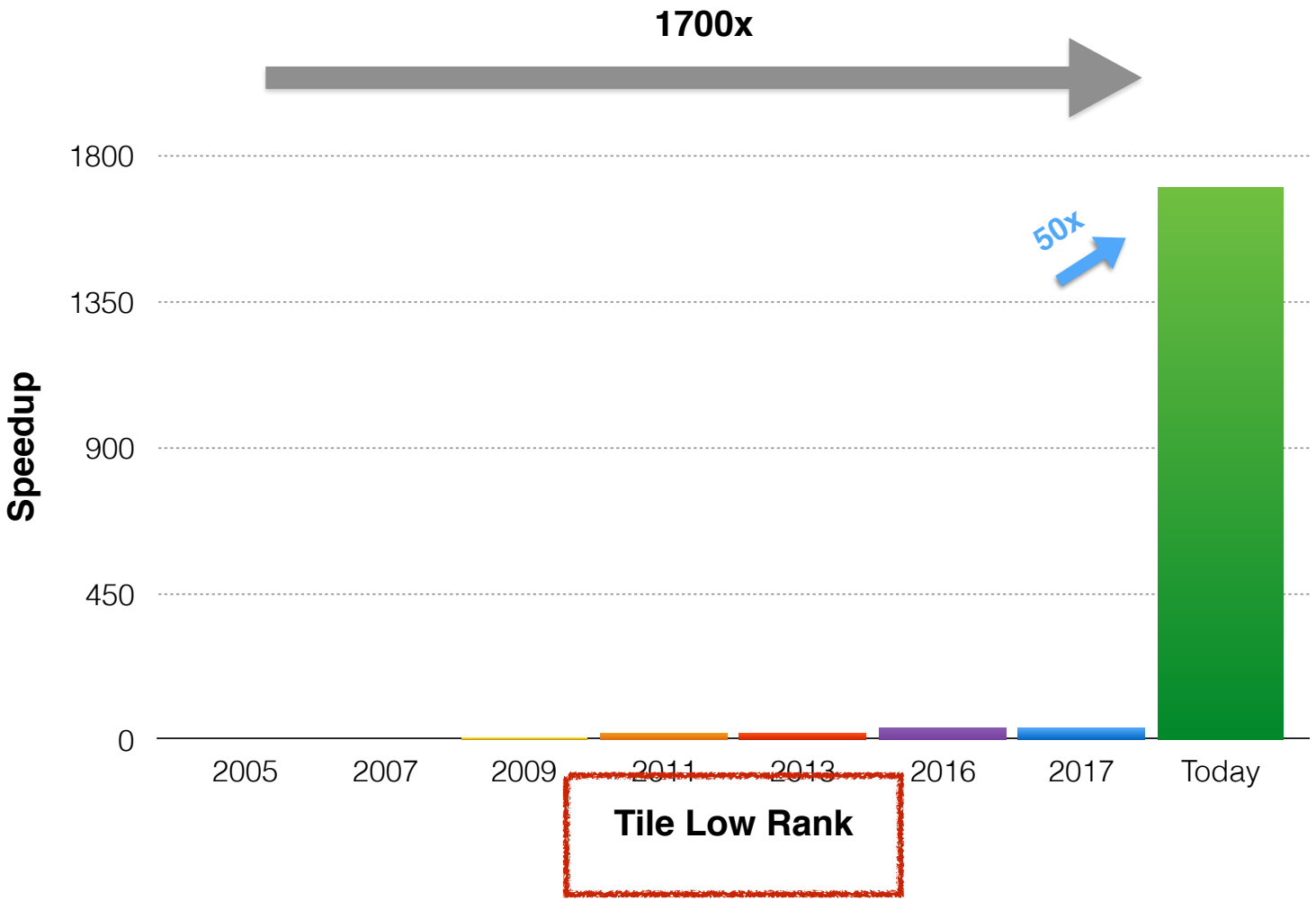
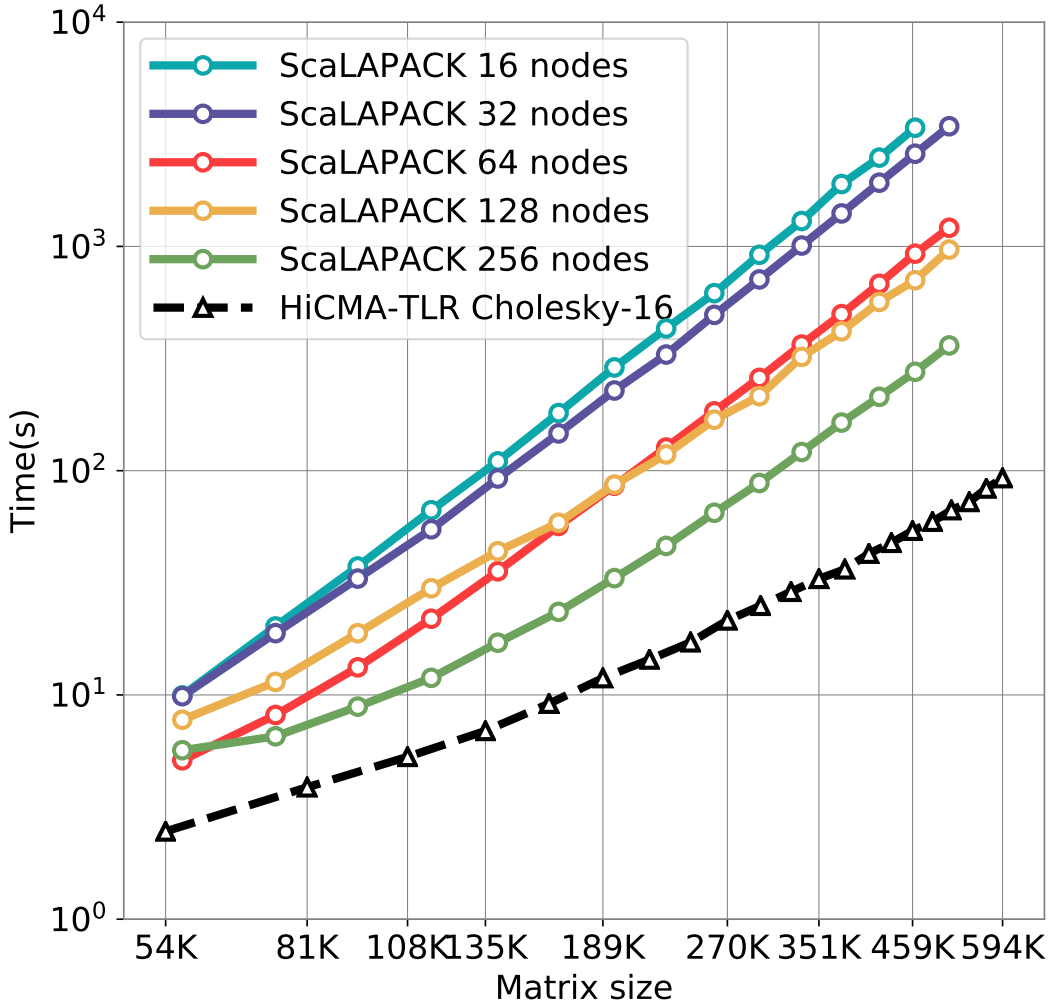
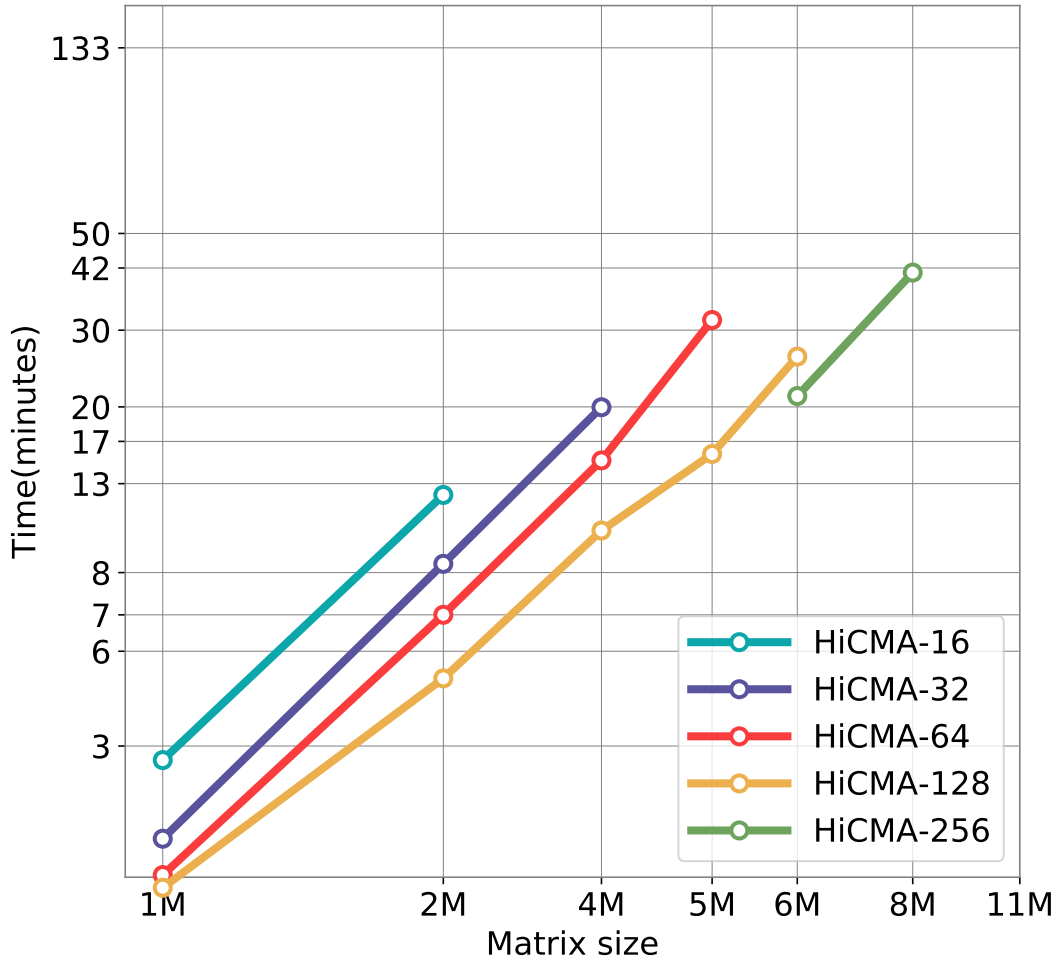


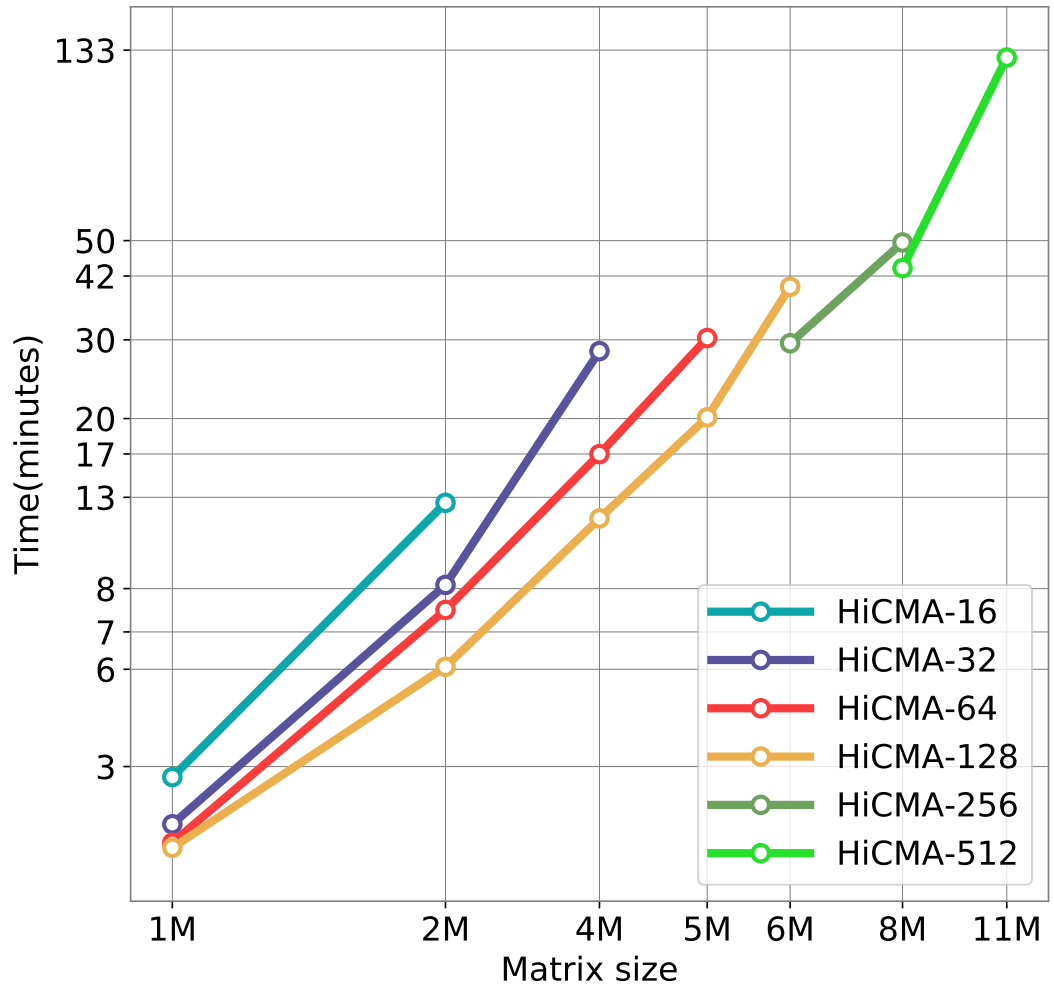
HiCMA Vs ScaLAPACK on Distributed-Memory Systems



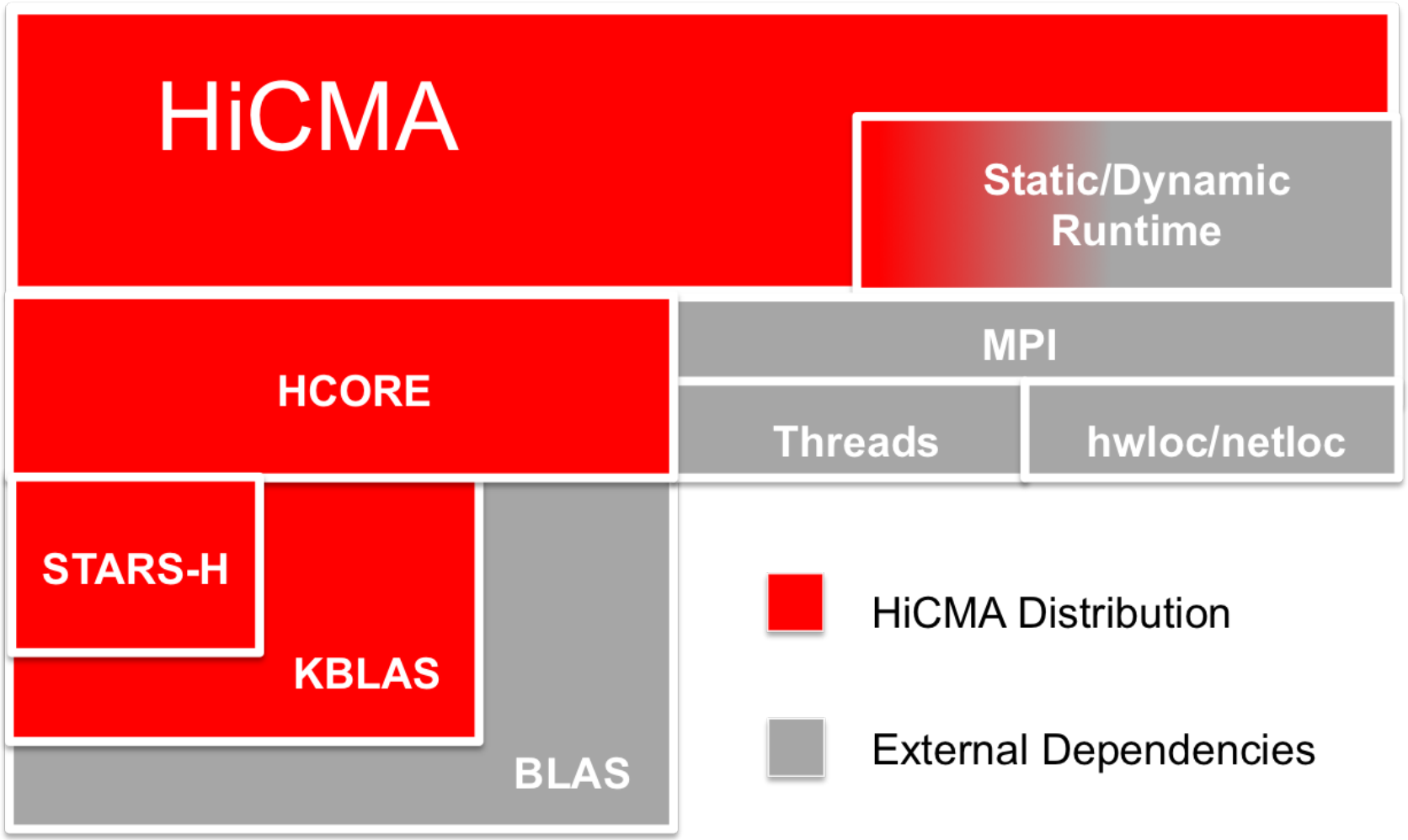
TLR Cholesky up to 11M (*Shaheen-2*, HSW, Statistics - SqExp kernel, acc=10^{-9})



TLR Cholesky up to 8M (SKL Cluster, Turbo On, Statistics - SqExp, acc=10^{-9})



The HiCMA Library



Available at http://github.com/ecrc/hicma