l'Observatoire de Paris — LESIA
Laboratoire d'Études Spatiales et d'Instrumentation en Astrophysique

Durham University

MICROGATE

PLDA

Efficient supervision strategy for tomographic AO systems on E-ELT

European Commission

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Efficient supervision strategy for tomographic AO systems on E-ELT

- Supervisor module
- Learn
- Solver
- Improvements

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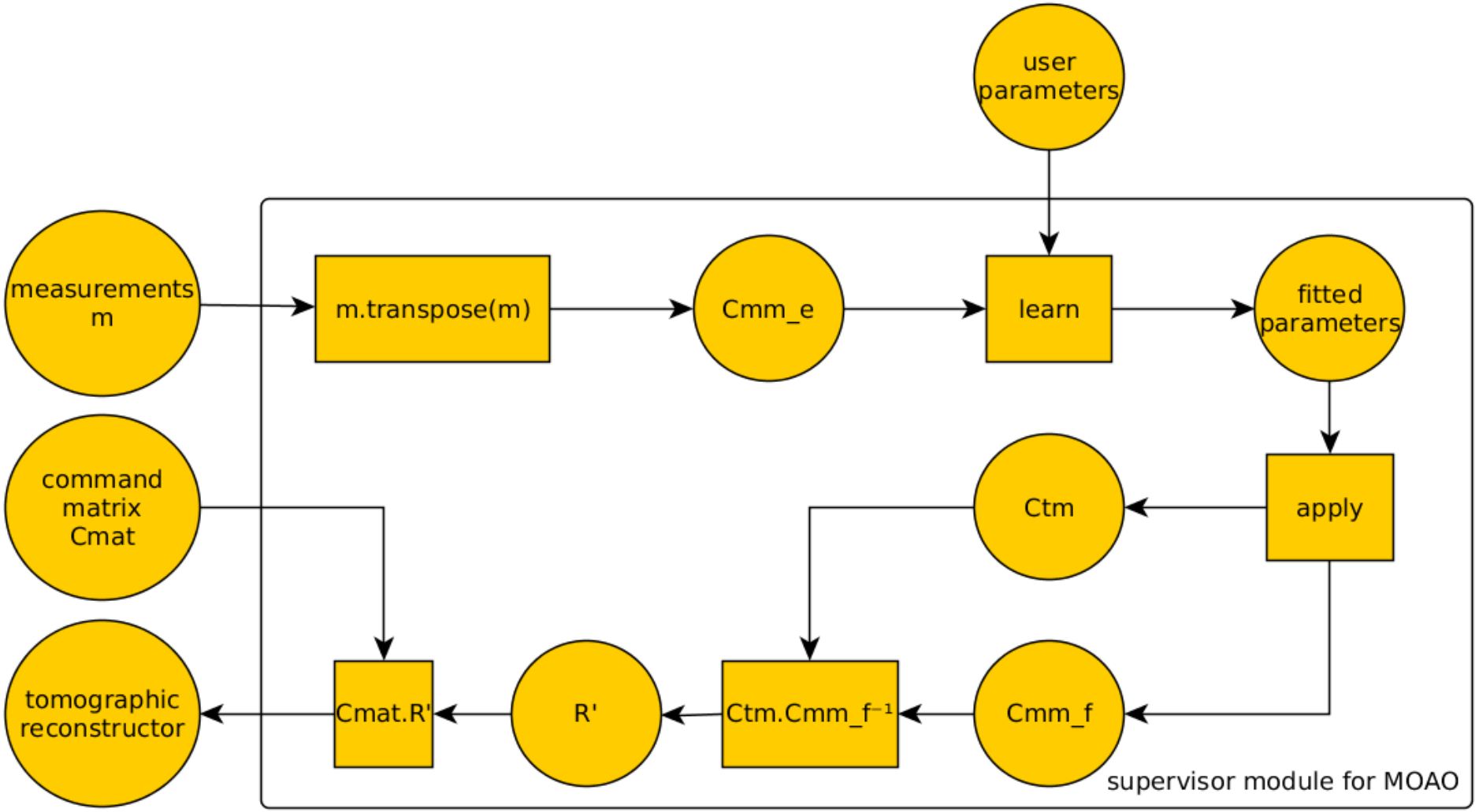
Supervisor module for MOAO



Learn

- Atmospheric parameters from measurements
- Model function f , possibility to compute independently:
  - element
  - layer
- Score function $F(x)=\sum_{k=1}^{N^2}[Cmm_k - f_k(x)]^2$

Learn

Algorithm 3.16. Levenberg–Marquardt method

begin

$k := 0; \quad \nu := 2; \quad \mathbf{x} := \mathbf{x}_0$

$\mathbf{A} := \mathbf{J}(\mathbf{x})^\top \mathbf{J}(\mathbf{x}); \quad \mathbf{g} := \mathbf{J}(\mathbf{x})^\top \mathbf{f}(\mathbf{x})$

$found := (\|\mathbf{g}\|_\infty \le \varepsilon_1); \quad \mu := \tau * \max\{a_{ii}\}$

while (**not** *found*) **and** $(k < k_{\max})$

$k := k+1; \quad$ Solve $(\mathbf{A} + \mu\mathbf{I})\mathbf{h}_{\text{lm}} = -\mathbf{g}$

if $\|\mathbf{h}_{\text{lm}}\| \le \varepsilon_2(\|\mathbf{x}\| + \varepsilon_2)$

$found := \mathbf{true}$

else

$\mathbf{x}_{\text{new}} := \mathbf{x} + \mathbf{h}_{\text{lm}}$

$\varrho := (F(\mathbf{x}) - F(\mathbf{x}_{\text{new}}))/(L(\mathbf{0}) - L(\mathbf{h}_{\text{lm}}))$

if $\varrho > 0$ {step acceptable}

$\mathbf{x} := \mathbf{x}_{\text{new}}$

$\mathbf{A} := \mathbf{J}(\mathbf{x})^\top \mathbf{J}(\mathbf{x}); \quad \mathbf{g} := \mathbf{J}(\mathbf{x})^\top \mathbf{f}(\mathbf{x})$

$found := (\|\mathbf{g}\|_\infty \le \varepsilon_1)$

$\mu := \mu * \max\{\frac{1}{3}, 1 - (2\varrho - 1)^3\}; \quad \nu := 2$

else

$\mu := \mu * \nu; \quad \nu := 2 * \nu$

end

Learn

$$J_{ij} = \frac{\partial f_i}{\partial x_j} \forall (i, j) \in [\![1, N^2]\!] x [\![1, np]\!]$$

$$H = J^T . J$$

$$g = J^T . (Cmm - f(x))$$

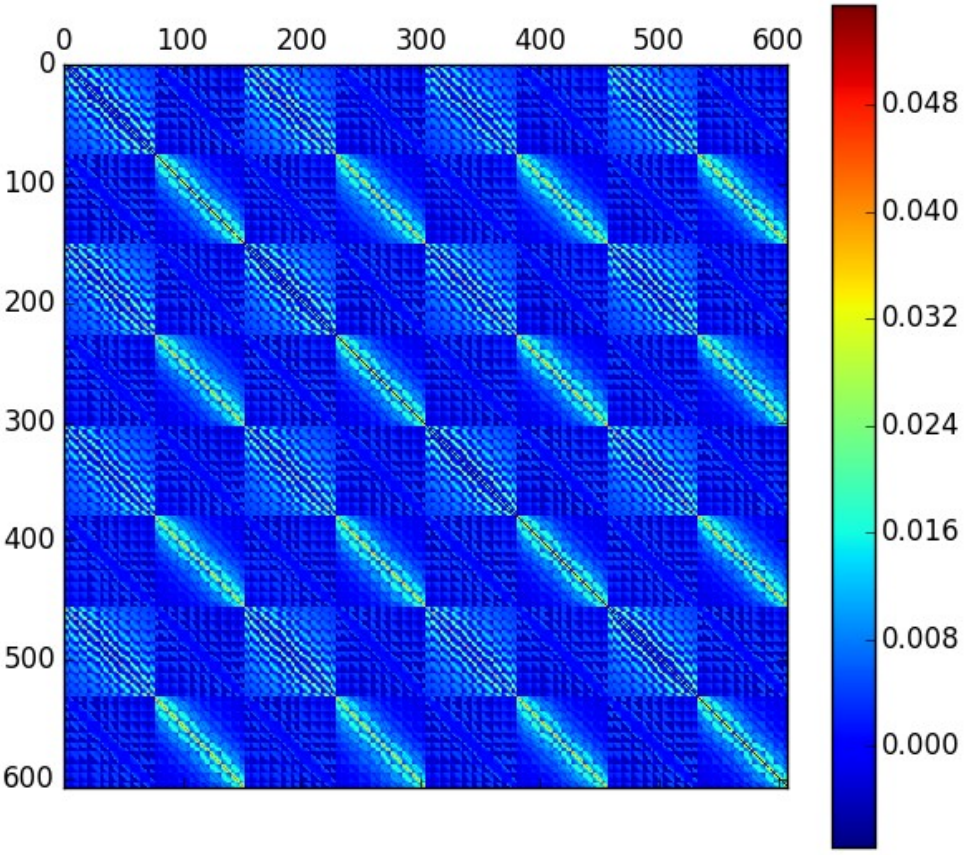
$$H_{i,j} = \sum_{k=1}^{N^2} \frac{\partial f_k}{\partial x_i} \cdot \frac{\partial f_k}{\partial x_j}$$

$$g_i = \sum_{k=1}^{N^2} \frac{\partial f_k}{\partial x_i} \cdot (Cmm_k - f_k(x))$$

- Parameters bind to layers

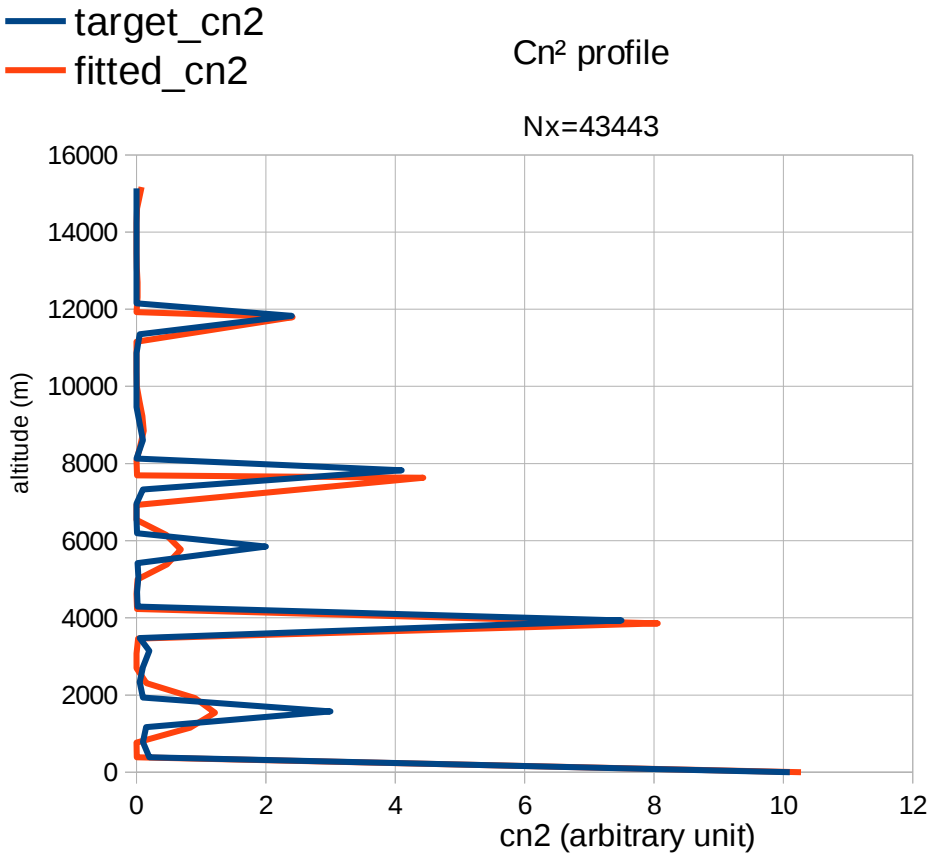
Learn

- Approximation by removing XY components



Learn

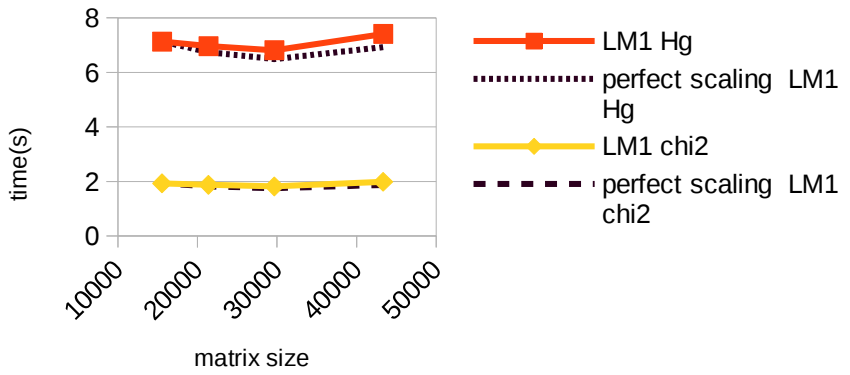
- 2 LM (5 layers, 40 layers)
- Profile score=3.08 (sum(Cmm²)=27500)



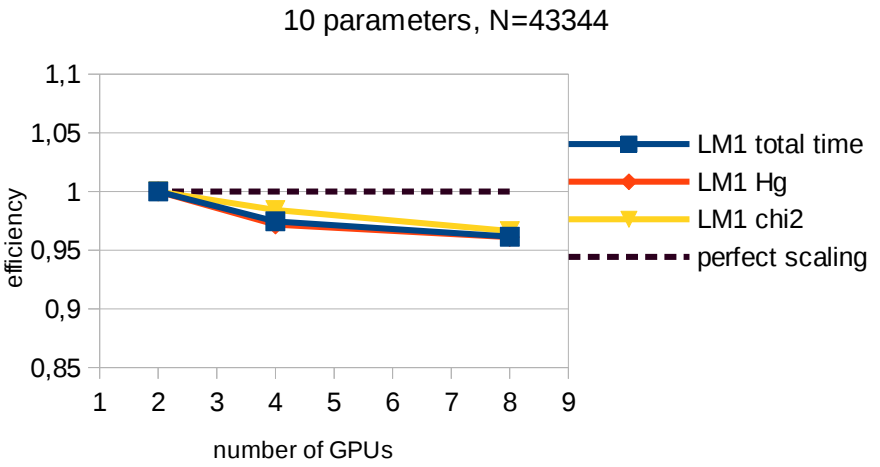
Learn

- Intel(R) Xeon(R) CPU E5-2620 v3 @ 2.40GHz + 4 Tesla K80
- First LM : 150s Second LM : 1303 s

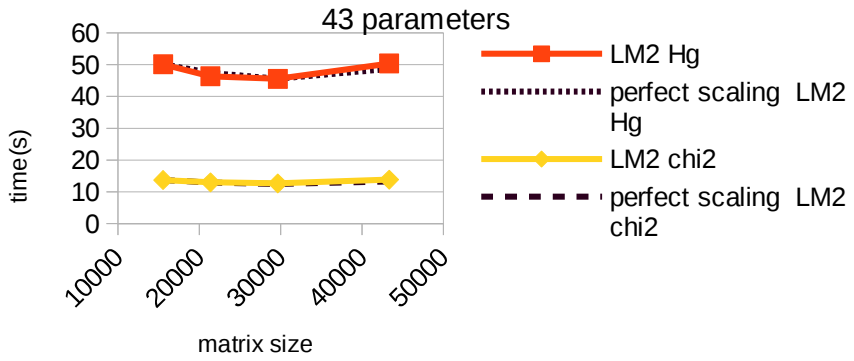
Weak scaling for the first LM



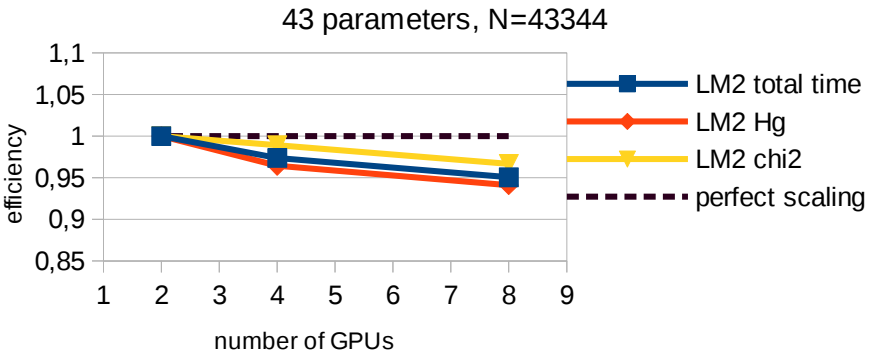
strong scaling for the first LM



Weak scaling for the second LM



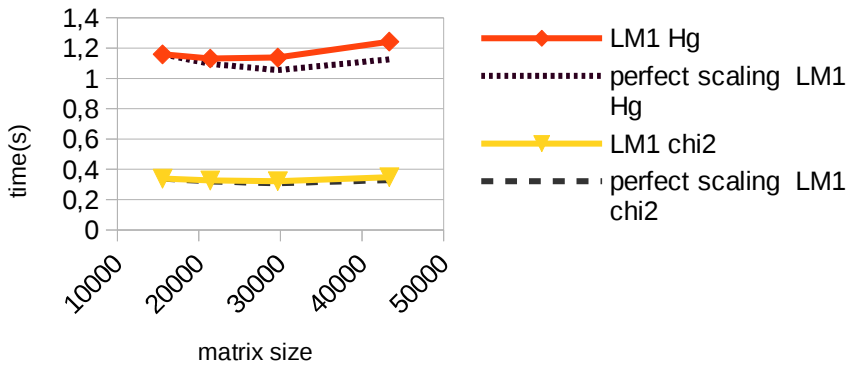
strong scaling for the second LM



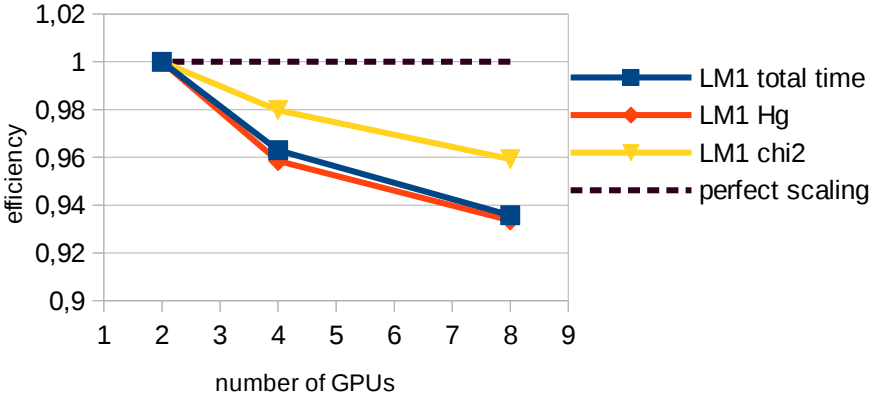
Learn

- Intel(R) Xeon(R) CPU E5-2698 v4 @ 2.20GHz + 8 P100
- First LM : 25.5s Second LM : 213,8s

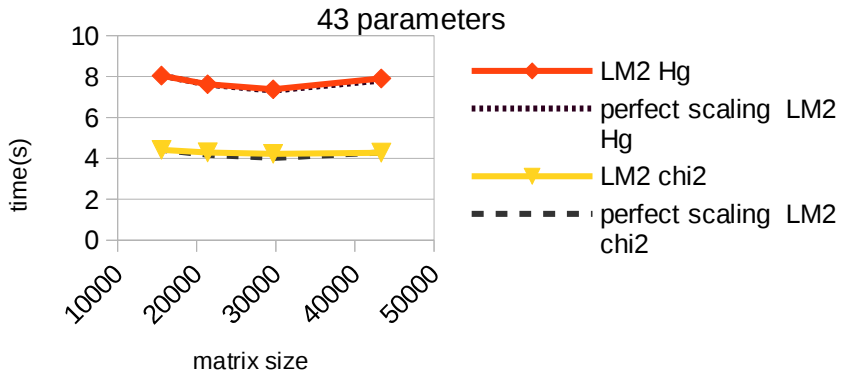
Weak scaling for the first LM



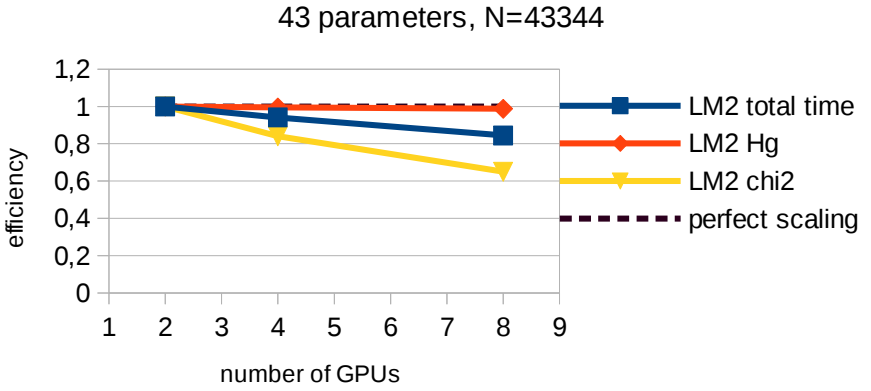
strong scaling for the first LM



Weak scaling for the second LM



strong scaling for the second LM



Solver

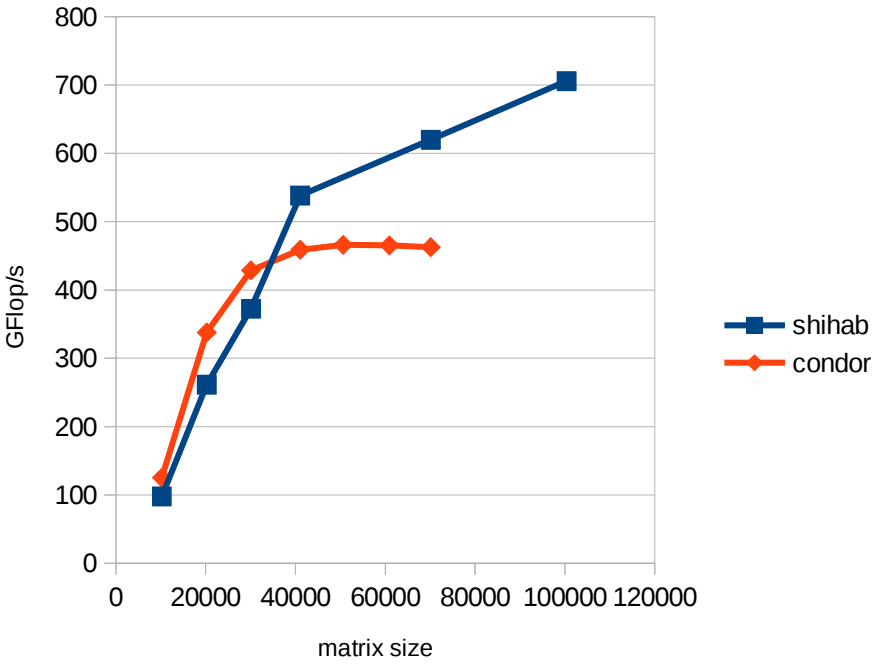
- Generate matrices Ctm and Cmm_f
- $R' = Ctm \cdot Cmm_f^{-1}$
- posv solve $A.x = B$
- Decompose posv
  - potrf
  - trsm
  - trsm

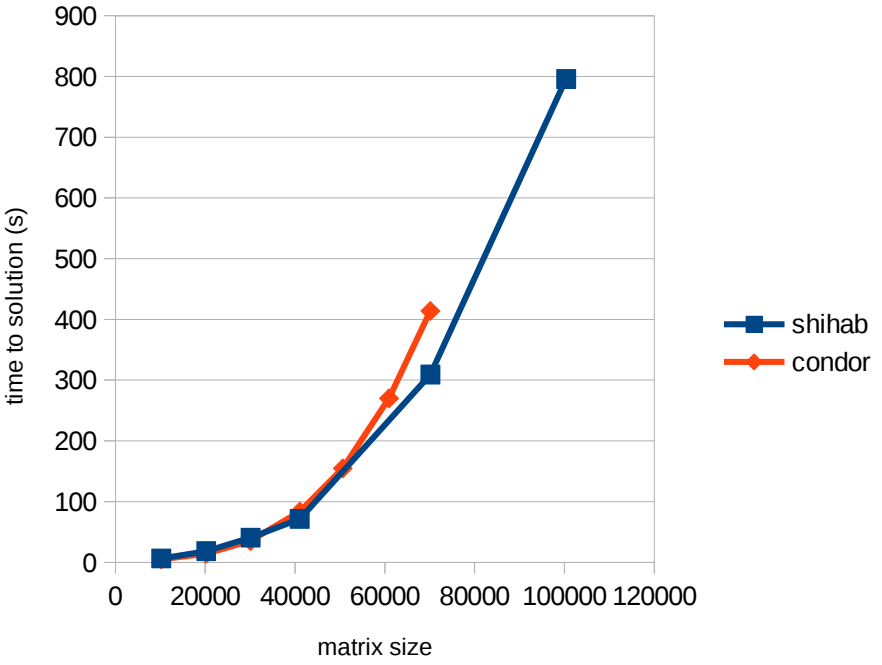
Solver

- Implementation with multiple libraries
  - LAPACK
  - PLASMA
  - Chameleon
- Several architectures
  - CPU Two sockets eighteen-cores Intel Haswell E5-2699 v3 @ 2.30GHz (shihab)
  - KNL One socket 64 cores Intel(R) Xeon Phi(TM) CPU 7210 @ 1.30GHz (condor)
  - GPU
    - Two sockets ten-cores Intel Ivy Bridge E5-2680 v2 @ 2.80GHz + 2K40
    - Intel(R) Xeon(R) CPU E5-2698 v4 @ 2.20GHz + 8 P100

Solver

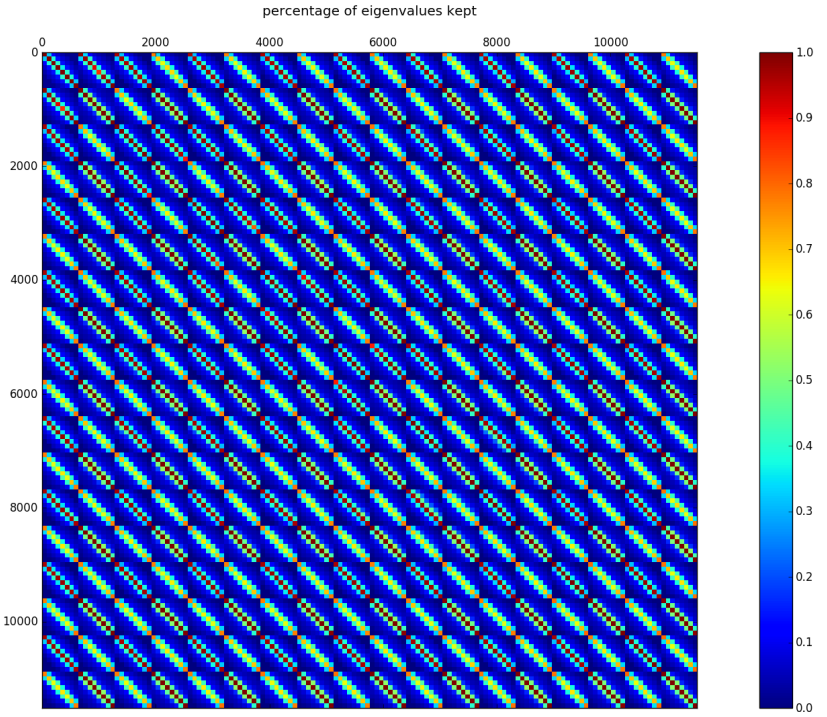
- Validation of the results against yorick application
- performance





Improvements

- Hierarchical matrices
  - Hierarchy of blocks
  - Data sparse (low rank blocks)
  - Singular values decomposition



- Compression up to 80 %
- Faster matrix generation
- H-matrix in solver ?


Green
Flash

Thank you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