



Speed up sparse MATVEC for Structured matrices

Goal:

Improve the performance of iterative solvers for large-scale discretised PDE problems.

Implementation:

In C++ within the deal.ii scientific library.

Large impact:

- Structured matrices occur very often.
- MATVEC is a major computational kernel in iterative methods and preconditions.

Key words:

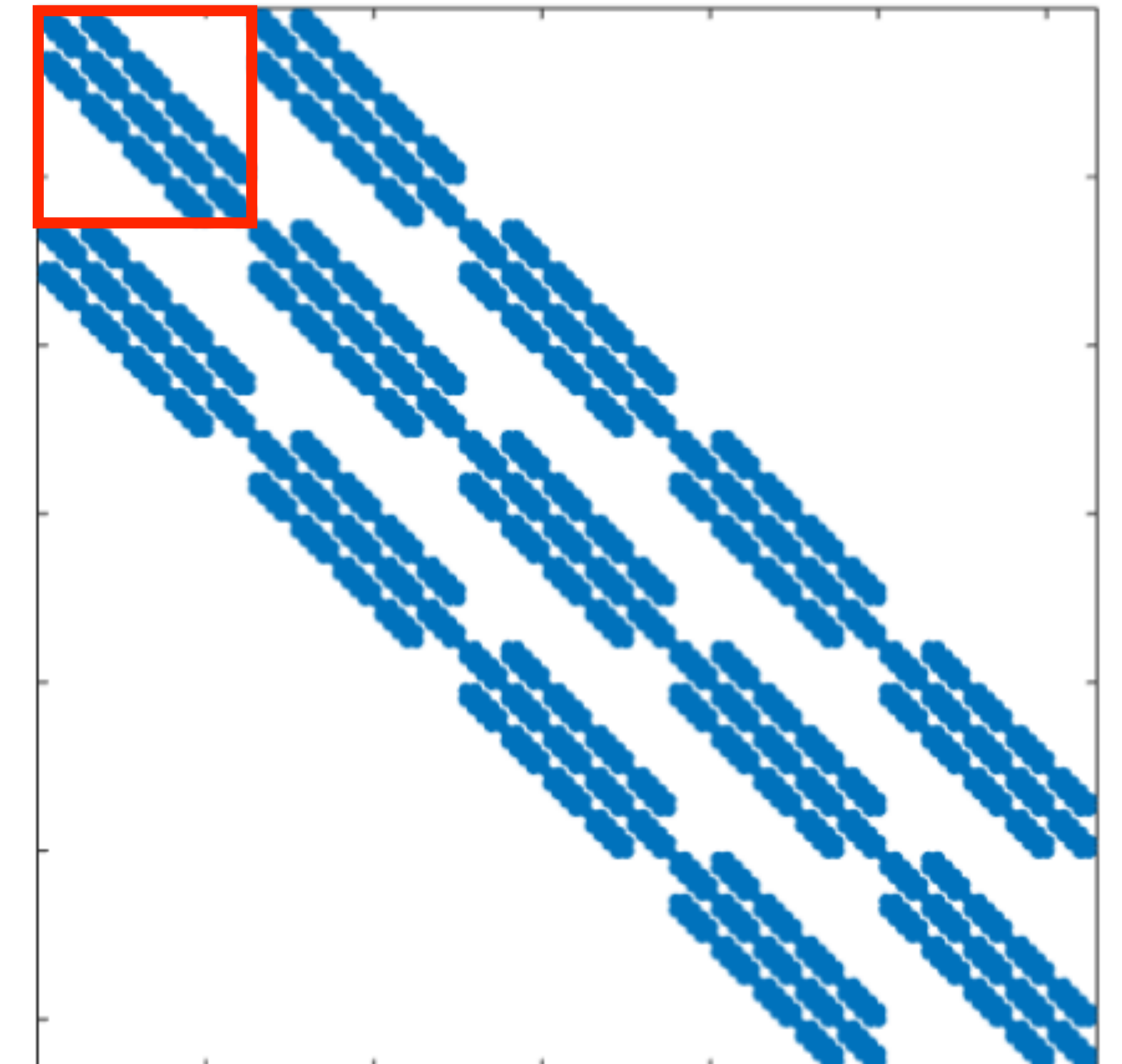
GLT, Multigrid

Reference

- [1] Demmel. *Applied Numerical Linear Algebra*. SIAM, 1997
- [2] Carlo Garoni and Stefano Serra-Capizzano. *Generalized Locally Toeplitz Sequences: Theory and Applications*, 2017

Diagonal Storage format:

$$\begin{matrix} & -1 & 0 & 1 & 2 & 3 & 4 & 5 \\ \begin{matrix} 0 \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{matrix} & \begin{pmatrix} 4 & -2 & 0 & 0 & 0 & 0 & 0 \\ -2 & 4 & -2 & 0 & 0 & 0 & 0 \\ 0 & -2 & 4 & -2 & 0 & 0 & 0 \\ 0 & 0 & -2 & 4 & -2 & 0 & 0 \\ 0 & 0 & 0 & -2 & 4 & -2 & 0 \\ 0 & 0 & 0 & 0 & -2 & 4 & 0 \end{pmatrix} & \end{matrix}$$



$$offset = (-1 \quad 0 \quad 1)$$

$$Values = \begin{pmatrix} 0 & 4 & -2 \\ -2 & 4 & -2 \\ -2 & 4 & -2 \\ -2 & 4 & -2 \\ -2 & 4 & -2 \\ -2 & 4 & 0 \end{pmatrix}$$

Result:

- For a **10000 x 10000** matrix with only ones on diagonal, diagonal storage class takes **2,54s** to solve the system.
- For the BB{3} matrix (4913 x 4913)

| | solve system |
|------------------------------|----------------|
| standard multiplication | 1.19s |
| diagonal (without inversion) | 0.0208s |

(Both with rhs of ones)

Participants:
Niklas Bergqvist
Tianhao Zhang

in collaboration with
Hreinn Juliusson
Johanna Brodin

Supervisor:
Maya Neytcheva
Ali Dorostkar

Project of Scientific
Computing in 2017