MUMPS
A Multifrontal Massively Parallel Solver

MUMPS solves large systems of linear equations of the form Ax=b by factorizing A into A=LU or LDL

- Symmetric or unsymmetric matrices (partial pivoting)
- Parallel factorization and solution phases (uniprocessor version also available)
- Iterative refinement and backward error analysis
- Various matrix input formats
  * assembled format
  * distributed assembled format
  * sum of elemental matrices
- Partial factorization and Schur complement matrix
- Version for complex arithmetic
- Several orderings interfaced: AMD, AMF, PORD, METIS, SCOTCH

MAIN FEATURES

Recent features
- Symmetric indefinite matrices: preprocessing and 2-by-2 pivots
- Hybrid scheduling
- 2D cyclic distributed Schur complement
- Sparse multiple right-hand side
- Interfaces to MUMPS: Fortran, C, Matlab (S. Pralet, ENSEEIHT-IRIT) and Scilab (A. Favre, INRIA)

IMPLEMENTATION

- Distributed multifrontal solver (MPI / F90 based)
- Dynamic distributed scheduling to accommodate both numerical fill-in and multi-user environments
- Use of BLAS, ScalAPACK

A fully asynchronous distributed solver (VAMPIR trace, 8 processors)

AVAILABILITY

- MUMPS is available free of charge
- It is used on a number of platforms (CRAY, SGI, IBM, Linux, ...) and is downloaded once a day on average (applications in chemistry, aeronautics, geophysics, ...)
- If you are interested in obtaining MUMPS for your own use, please refer to the MUMPS home page

Some MUMPS users: Boeing, BRGM, CEA, Dassault, EADS, EDF, MIT, NASA, SAMTECH, ...

CURRENT RESEARCH: ACTIVE RESEARCH FEEDS MUMPS

On-going research on Out-of-Core solvers
(Ph.D. E. Aguilo, ENS Lyon and Ph.D. M. Slavova, CERFACS)
- Use disk storage to solve very large problems
- Parallel out-of-core factorization
- Preprocessing to minimize volume of I/O
- Scheduling for out-of-core solution

Related project: Grid TLSE
- Expertise website for sparse linear algebra
- On a user's specific problem, compare execution time, accuracy, memory usage, ... of various solvers
- Find best parameter values and reordering heuristics on a given problem

Memory minimizing schedules
- Multifrontal methods can use a large amount of temporary data
- By decoupling task allocation and task processing, we can reduce the amount of temporary data: new optimal schedule proposed in this context (Guermouche, L'Excellent, ACM TOMS)
- Memory gains:
  
  Active memory ratio (new algorithm vs Liu's ordering)

Preprocessing for symmetric matrices
(S. Pralet, ENSEEIHT-IRIT)
- Preprocessing: new scaling available, symmetric weighted matching and automatic tuning of the preprocessing strategies
- Pivoting strategy (2-by-2 pivot and static pivoting)
- Improvement:
  * factorization time
  * robustness in particular on KKT systems arising from optimization
  * memory estimation

Related: PARASOL, CARATE, GRID TLSE, SCARAB, SCIT, ...

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http://graal.ens-lyon.fr/MUMPS/
http://www.enseeiht.fr/lima/tlse/

The latest versions of MUMPS are public domain, based on public domain software described during the Eighth EU European project PARASOL (1998-1999). Since 1996, the developments are supported by CERFACS, ENSEEIHT-IRIT, and others in Europe, Asia.

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