DIRECT VS. ITERATIVE METHODS FOR NUMERICAL EM

CRITERIA	DIRECT	ITERATIVE
CONVERGENCE	BEST CHOICE	—
MEMORY (DENSE/SPARSE)	—	BEST CHOICE
PARALLEL IMPLEMENTATION	—	—
ERROR	BEST CHOICE	—
PROCESSING TIME		BEST CHOICE

SPARSE MATRICES

MATRICES DERIVED FROM PDE'S HAVE A NUMBER OF NONZERO ELEMENTS PROPORTIONAL TO THE MATRIX SIZE (m), AND A NUMBER OF TOTAL ELEMENTS OF $m \times m$.

EXAMPLE: MODEL OF HUMAN AT 1 mm RESOLUTION, $1800 \times 600 \times 300$ mm $\Rightarrow 324$ E6 $= m$ (EQUATIONS/UNKNOWNS). ASSUMING THE COEFFICIENT MATRIX IS TYPE FLOAT, AND EACH EQUATION RELATES TO 7 ELEMENTS,

$$324 \times 10^6 \times 7 \times 4 \approx \boxed{9.1 \text{ GB}}$$

OF RAM TO STORE NON-ZERO ELEMENTS.

BUT IF ALL OF THE MATRIX ELEMENTS NEED TO BE STORED,

$$m^2 \approx 1.05 \times 10^{17}$$

AND IF EACH COEFFICIENT IS A FLOAT,

$$1.05 \times 10^{17} \times 4 \approx \boxed{4.2 \times 10^8 \text{ GB}!!}$$

OF STORAGE ARE NEEDED.

FOR REAL EM NUMERICAL PROBLEMS, THERE ARE FREE QUALITY LIBRARIES AVAILABLE:

BLAS: OPTIMIZED VECTOR/MATRIX LIBRARY FOR DENSE MATRICES.

LAPACK: DENSE SYSTEM LINEAR ALGEBRA LIBRARY

IML++: ITERATIVE SOLVER LIBRARY (KRYLOV SUB-SPACE), WORKS WITH SPARSELIB++

SPARSELIB++: SPARSE MATRIX STORAGE LIBRARY.

FOR SMALLER PROBLEMS, MATLAB HAS SUPPORT FOR ITERATIVE AND DIRECT SOLVERS, AS WELL AS SPARSE MATRIX STORAGE:

REFER TO MATLAB LITERATURE AND EXAMPLE CODE PROVIDED IN THIS COURSE.