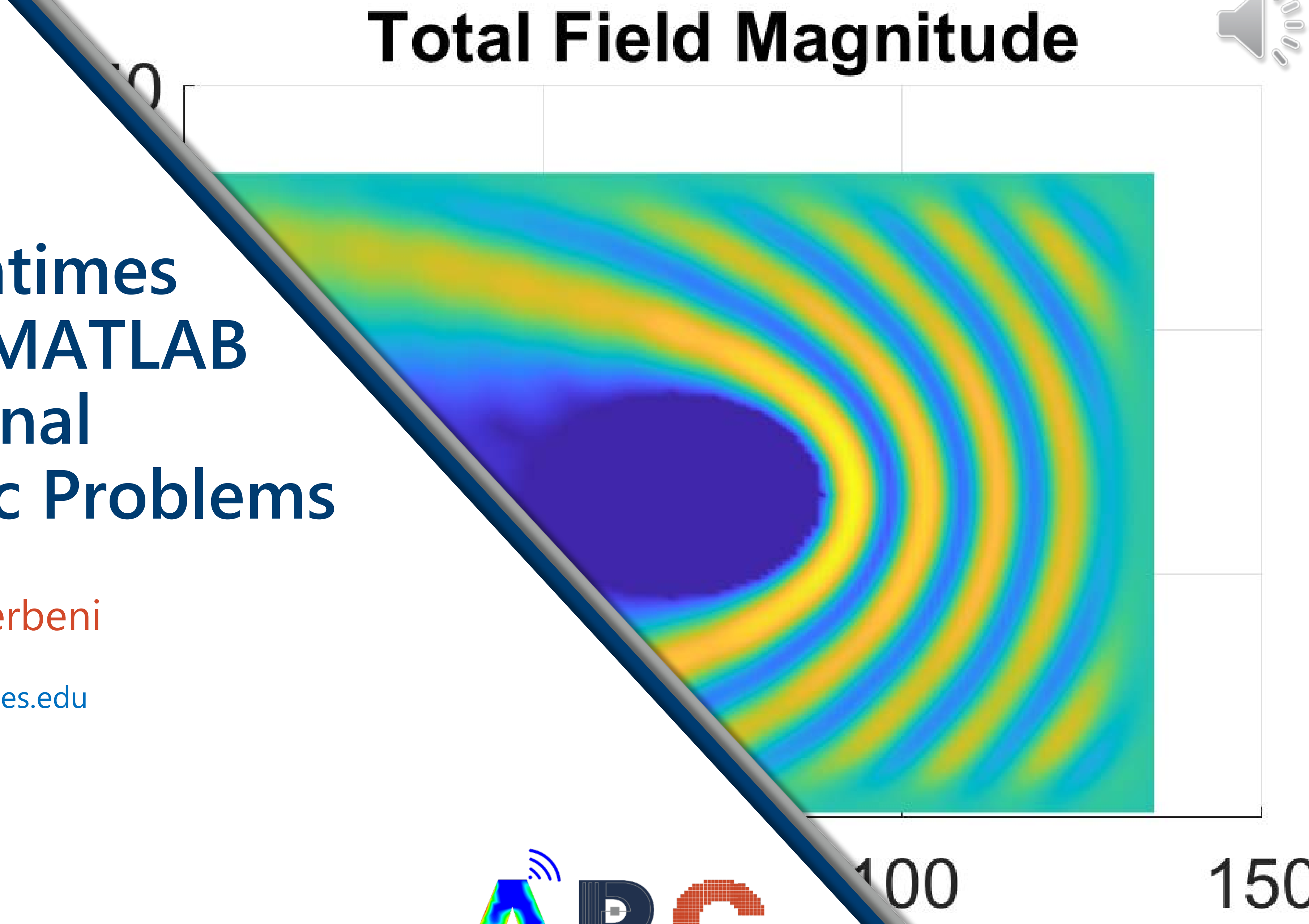
Comparing Runtimes of Python and MATLAB for Computational Electromagnetic Problems

Alec Weiss and Atef Elsherbeni

aweiss@mines.edu, aelsherb@mines.edu



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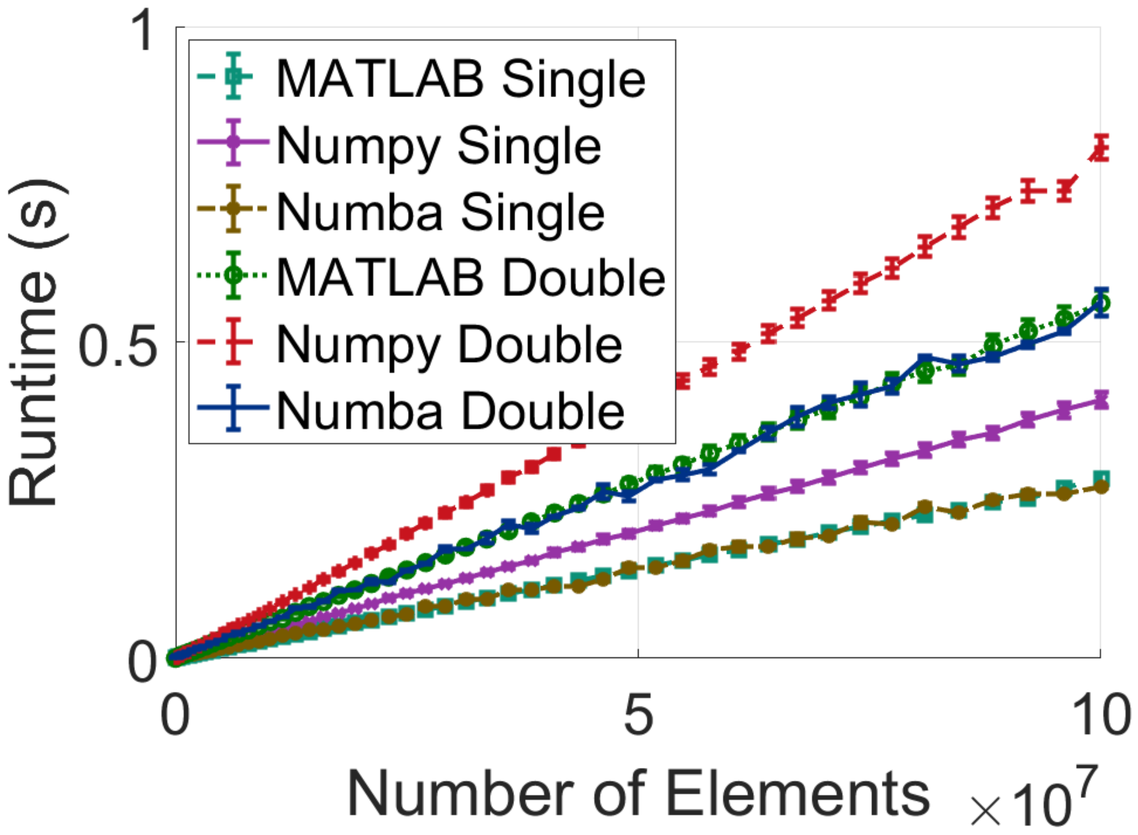
Antenna, RFID, and Computational EM Group

Introduction

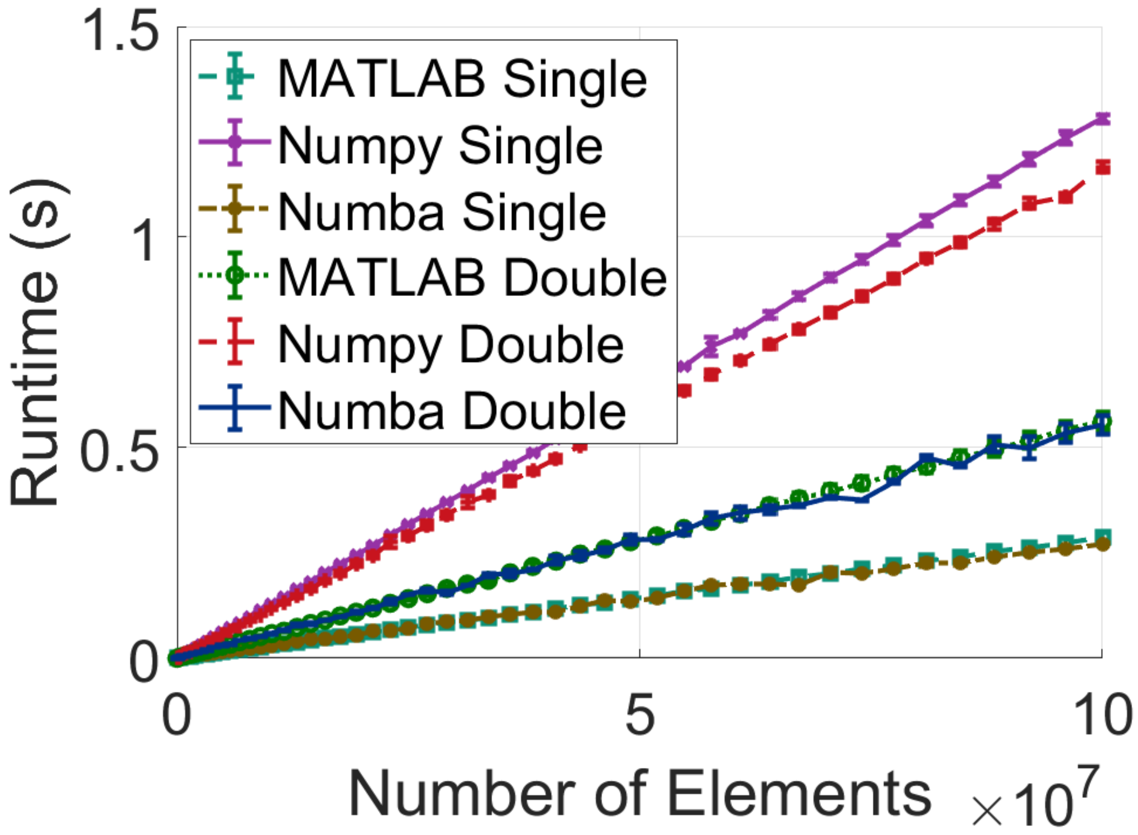
- MATLAB and Python are two commonly used modern programming languages
- Compare the speed of MATLAB and Python for Computational Electromagnetic (CEM) Problems
- CEM problems commonly deal with complex numbers
  - These are also used as both single and double precision
  - Many times also deal with dense and sparse matrix operations
- Multiple operations run for different sizes of problems
  - Basic operations (e.g. addition, multiplication)
  - Extended operations (e.g. exponentiation, summation)
  - Matrix Operations (e.g. matrix factorization, linear system solving)
- Real Problems tested

Basic Operations

Addition ($\boldsymbol{c} = \boldsymbol{a} + \boldsymbol{b}$)



Division ($\boldsymbol{c} = \boldsymbol{a}/\boldsymbol{b}$)



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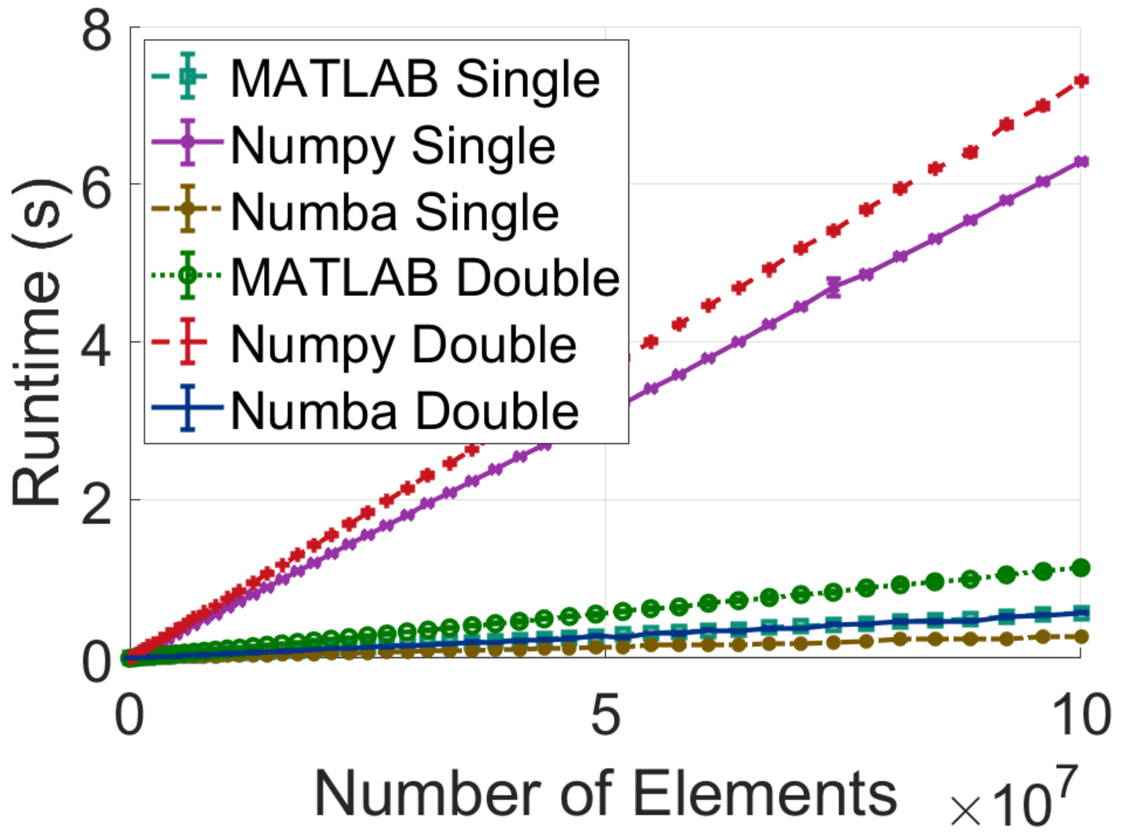
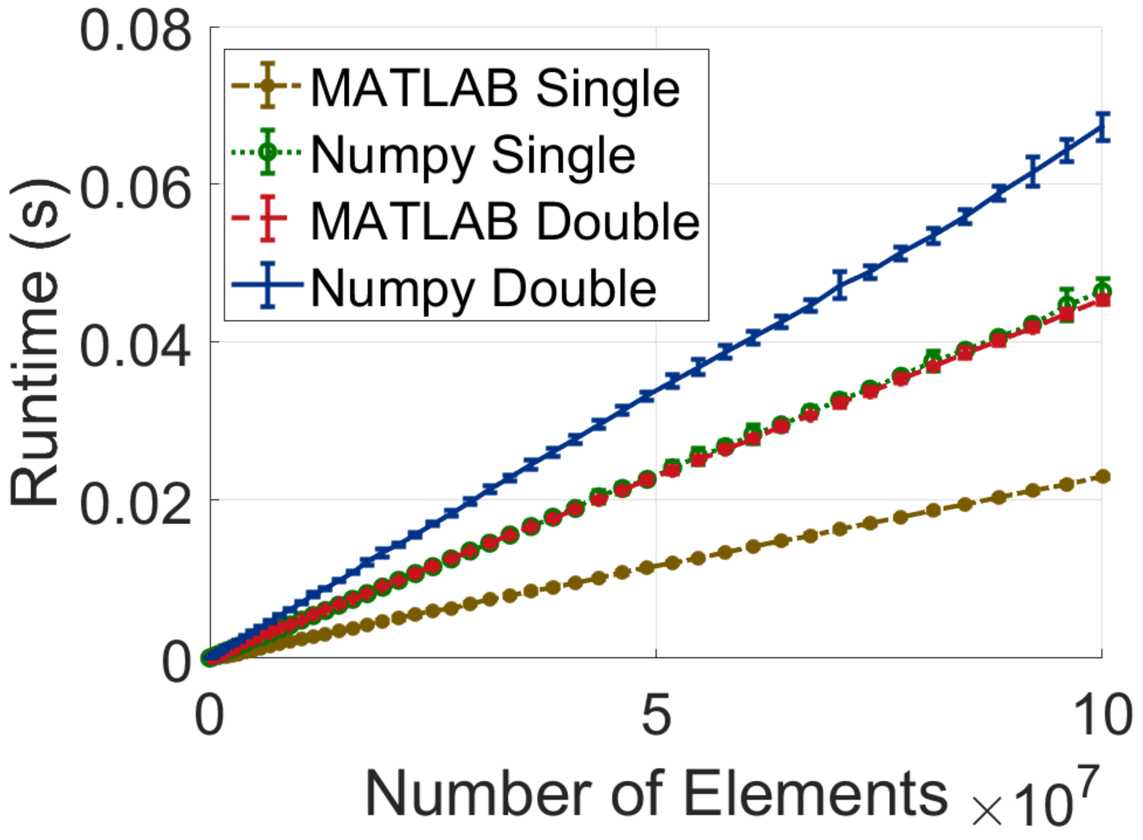
Extended Operations

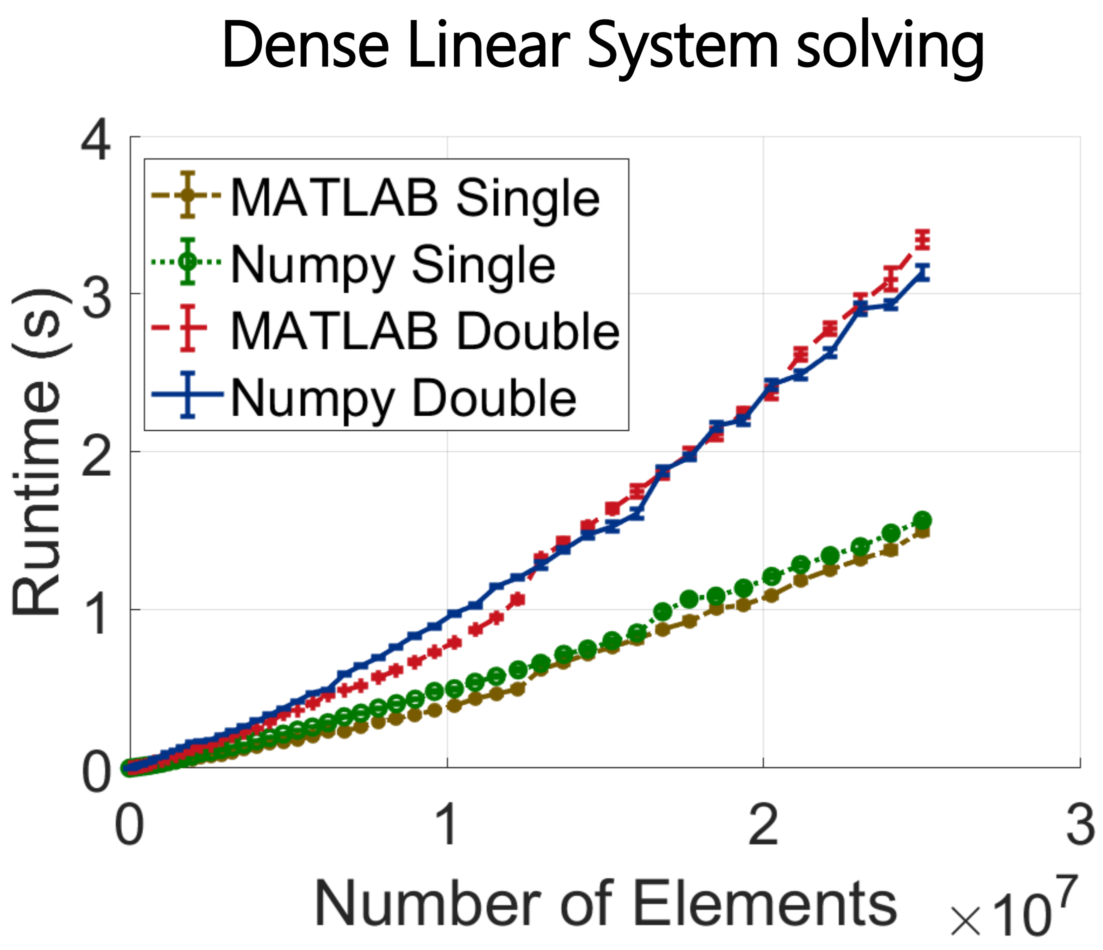
Combination ($c = a + b * exp(a)$)

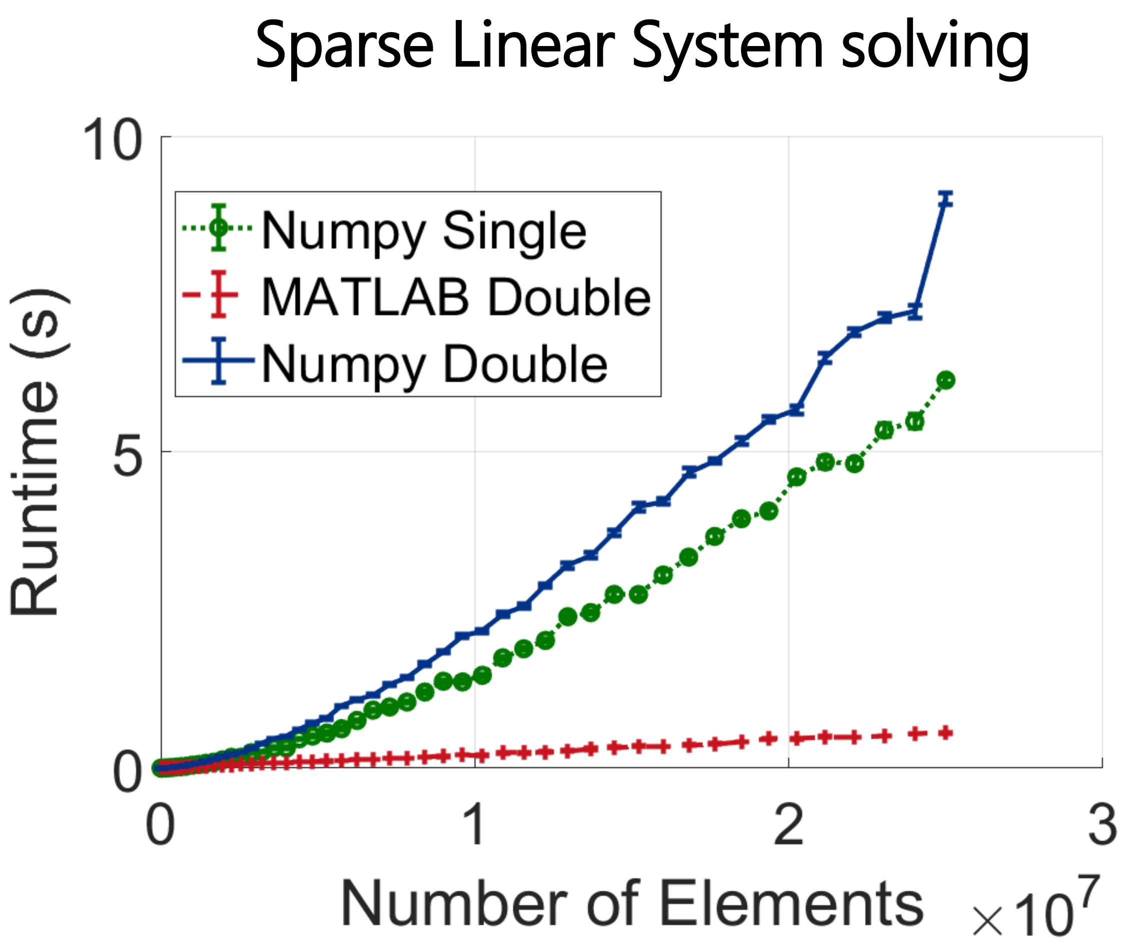


Summation ($c = Sum(a)$)



Matrix Operations





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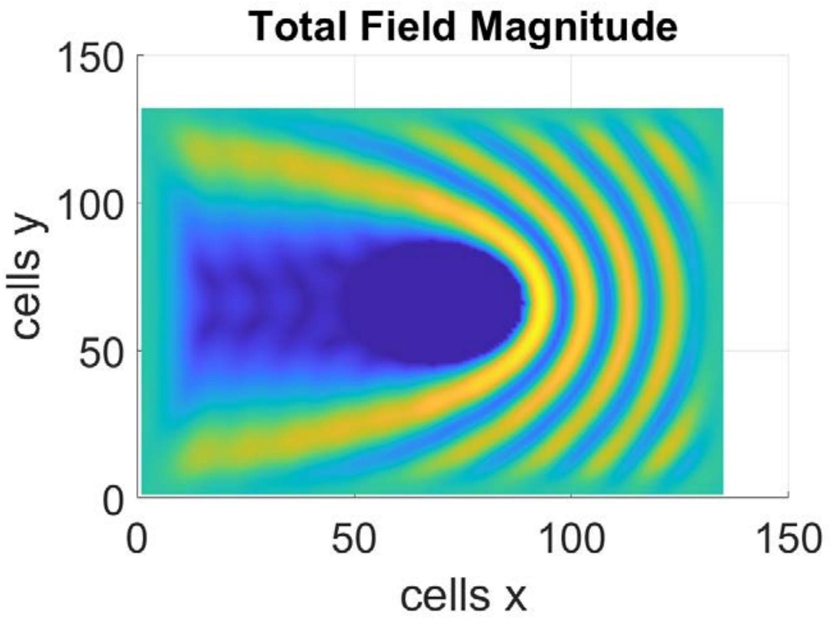
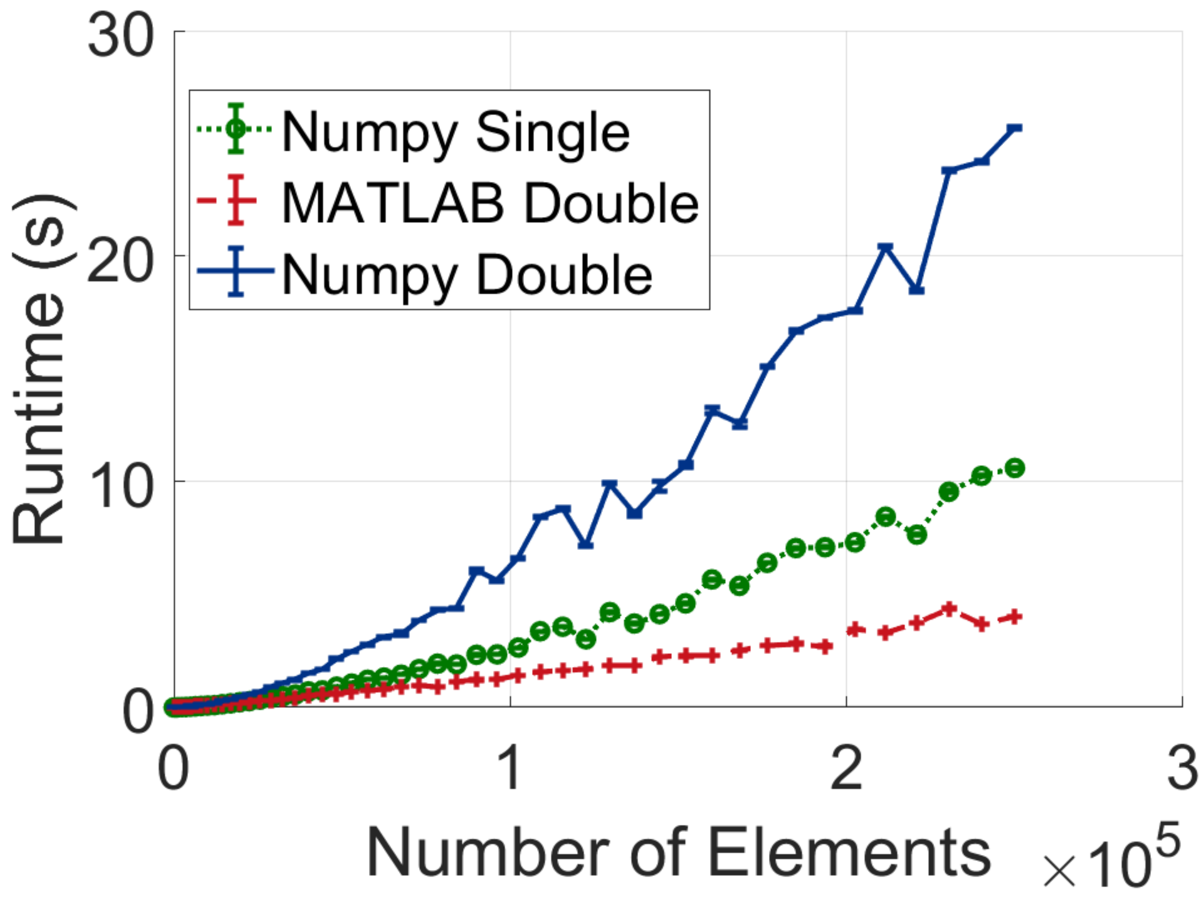
Finite Difference Frequency Domain Example

- Simulating 2D scattering from a cylinder using the Finite Difference Frequency Domain (FDFD) method
- The main computation from an FDFD simulation is dominated by the solving of a sparse system of linear equations



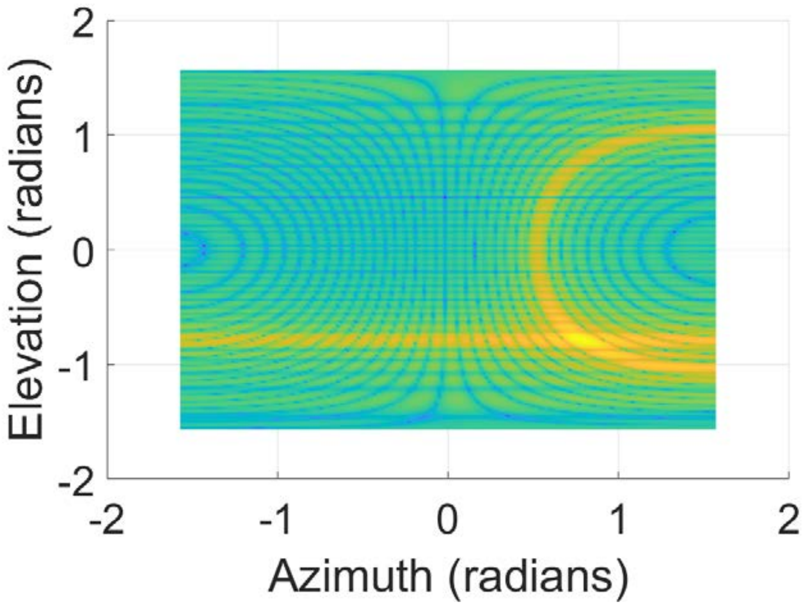


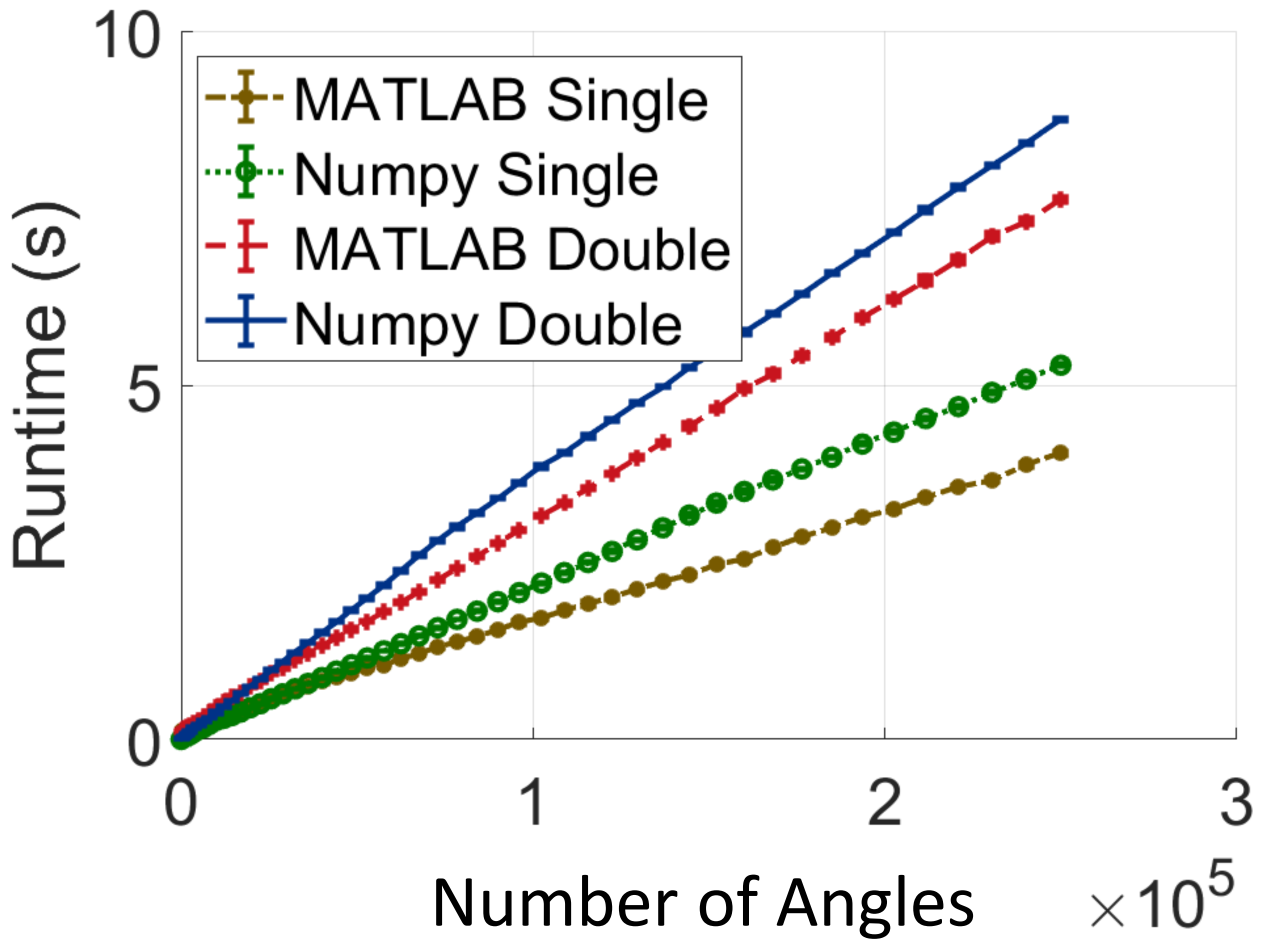
Angle of Arrival Example

- Angle of arrival estimation using conventional beamforming (CBF)
- The received value V at each steering angle θ, ϕ of an antenna array is calculated as

$$V(\theta,\phi) = \sum_{n=1}^{N} S_n e^{-jk\cdot r}$$

where S_n is the received value at each antenna element n





Conclusions

- MATLAB and python have similar performance in many situations
- For sparse matrices, MATLAB will drastically outperform Python
- For many CEM applications, Python can provide a competitive free alternative to MATLAB