NSF CRI CNS-0551504, ATLAS Support and Development

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- $100,000 total budget, all for student support
- Just finished first of two years
- Presently supporting one PhD student, Tony Castaldo
- Not hardware acquisition: Community Resource Development:
  - ATLAS support and development
    → What is ATLAS? ⇒ next slide
What is ATLAS?
- Provides high performance linear algebra routines:
  - BLAS, some LAPACK
- Automatically adapts itself to differing architectures using empirical techniques

Why is ATLAS needed?
- Well-tuned linear algebra routine runs orders of magnitude faster than generic implementation
- Hand-tuning is architecture specific
- No such thing as enough compute speed for many scientific codes
Usage/Tech Transfer

- Scientific simulation:
  - physics, chemistry, biology, astronomy, engineering, math
- Almost all supercomputers
- Many OSes include ATLAS:
  - OS X, most Linux & BSDs
- Most PSEs:
  - Maple, Mathematica, Matlab, Octave
- Multitude of software:
  - GSL, HPL, SciPy, R, some compilers, etc.

Award Progress

- 20 developer releases
- 1st stable release in almost 4 years this summer
- More than 58,000 direct downloads during award
  - Most users get ATLAS via repackegers
- Error analysis research
  → next slide
New Research
Reducing Error in FP Computations

- Needed to guarantee stability in face of transformation
- Increasingly important as memory and performance expand
- Submitted to SISC, available as working note:

- Initial work covers dot product, which accounts for most of the error of many algorithms:
  - Research undertaken by Tony Castaldo (PhD candidate),
    - Faculty: R. Clint Whaley, Anthony Chronopoulos
  - Produce tighter bound for forward error, improved notation,
  - Survey error prop of several of most important algorithms,
  - Present a new class of dp (superblock) which subsumes these:
    - Also produces new algorithms, allowing tuning of error and mem/perf tradeoffs
  - Statistical studies show large difference in practice.
Error Studies on Mixed Sign Data
Averaged over 10,000 random vectors

(Total Abs Canonical Error) / (Total Abs Target Error)
X, Y in [-1, +1]  10,000 Trials per point per algorithm

N = 1000 to 100,000 Step 1000

Ratio

Pairwise
Auto Super Block
Super Block 60
Auto Block
Block 60
Canonical
Error Studies on Same Sign Data
Averaged over 10,000 random vectors

(Total Abs Canonical Error) / (Total Abs Alternative Error)
X, Y in [0, 1] 10,000 Trials per point per algorithm

N = 1000 to 100,000 Step 1000
Further details

- **Working note:**
  

- **ATLAS homepage:**
  
  http://math-atlas.sourceforge.net/

- **Author homepages:**
  
  http://www.cs.utsa.edu/~whaley/
  http://www.cs.utsa.edu/~atc/
  http://www.cs.utsa.edu/~castaldo/
Absolute Error by Algorithm - Mixed Sign
Averaged over 10,000 random vectors

Error Comparison, Mixed Sign, Various Algorithms
X,Y in [-1, +1] 10,000 Trials per Point per Algorithm

Error in Machine Epsilons

Pairwise
Super Block 60
Auto Super Block
Block 60
Auto Block
Canonical

N = 1000 to 100,000 step 1000