Algorithms and Computation in Signal Processing

special topic course 18-799B
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Summary of Insights so Far

Comparison Atlas, Sparsity, FFTW

	Atlas (MMM)	Sparsity/Bebop (sparse MVM)	FFTW
Cache optimization (locality)	Blocking	Blocking (rarely useful)	recursive FFT, fusion of steps
Register optimization (locality)	Blocking	Blocking (determines sparse format)	Scheduling of small FFTs
Optimized basic blocks	Unrolling, instruction ordering, scalar replacement, simplifications (for FFT)		
Other optimizations			Precomputation of constants
Adaptivity	Search over blocking parameters	Search over register blocking size	Search over recursion strategy

Guideline for writing fast Code (I)

- Avoid obvious mistakes
  - Know the available algorithms: use good algorithms
  - Precompute once were possible (e.g., constants)
  - Give the compiler a chance: write simple code, avoid complicated data structures
  - Understand were the runtime is wasted: code profiling
  - Use good compiler flags, try alternatives
- Optimization for caches
  - Recursive is better then iterative
  - Understand your code in terms of cache behavior and try to improve
  - Know your cache size and maybe other parameter

Guideline for writing fast Code (II)

- Basic block optimization
  - For the innermost kernels use unrolled code: no loops, recursive calls or other control structures
  - Order instructions for register locality and/or instruction parallelism; scalar replacement for variables being reused; other optimizations
  - Maybe: check assembly code
- Adaptivity through search over alternatives
  - Accept that you can't know the right answers for all choices
  - Search over a relevant subset of possible algorithms and/or implementation options
- After optimization check whether you still use the right algorithm

Convolution/Filtering

- Circular convolution
- Linear convolution
- Correlation

- Reference: Aca Gačić, *Automatic Implementation and Platform Adaptation of Discrete Filtering and Wavelet Algorithms*, Ph.D. thesis, Electrical and Computer Engineering, Carnegie Mellon University, 2004

- Blackboard