



Stream Programming

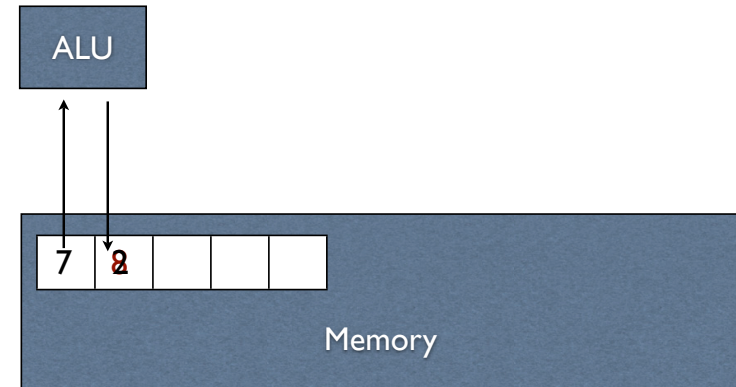
for high-performance computing

CS334 F09
Prof. McGuire
Williams College

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Processor Architecture

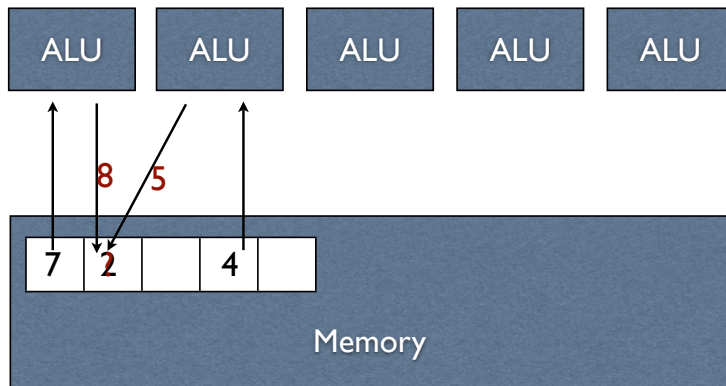
Arithmetic Logic Unit



2

Multi-Processor

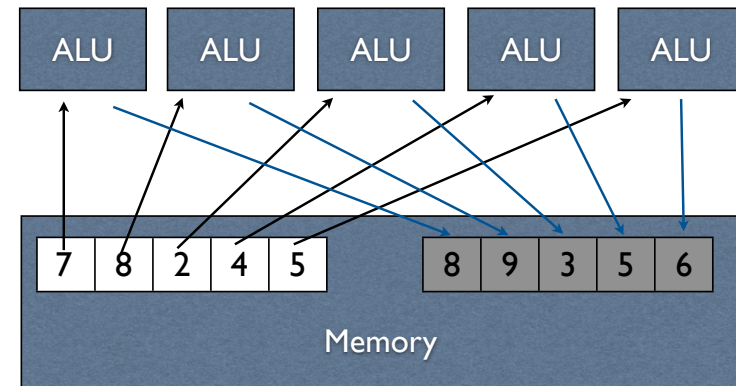
Arithmetic Logic Unit



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Stream Programming

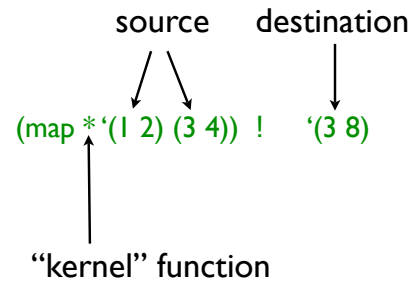
Arithmetic Logic Unit



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Stream Primitives

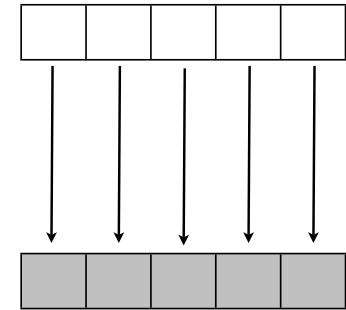
- Map
- Reduce
- Scatter
- Gather



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Map

- Apply a function to all elements
- Matrix addition
- Audio adjustment

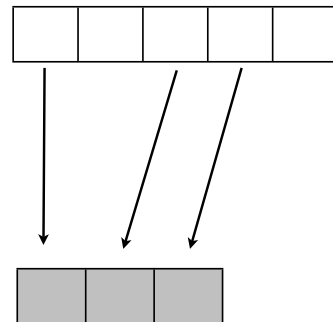


(map * '(1 2) (3 4)) ! '(3 8)

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Reduce (Filter)

- Drop elements that fail a predicate
- Strip outliers
- Parse whitespace

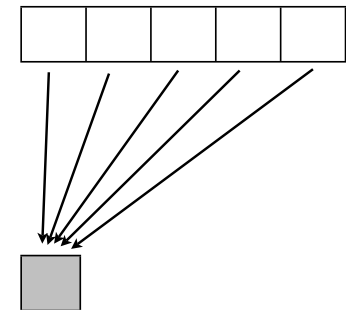


(filter even? '(1 2 3 4)) ! '(2 4)

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Reduce (Fold)

- Combine elements
- Summation
- Average
- Maximum



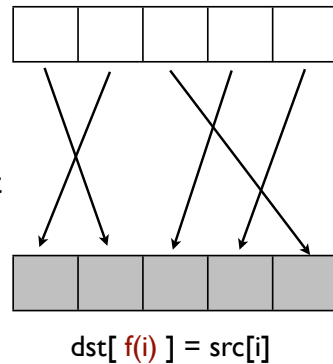
(foldl + 0 '(1 2 3 4)) ! 10

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Scatter (“Push”)

- Iterate over source, compute destination index

- Radix, Insertion, Quick sort
- Hash table insertion
- Permutation
- Rasterization

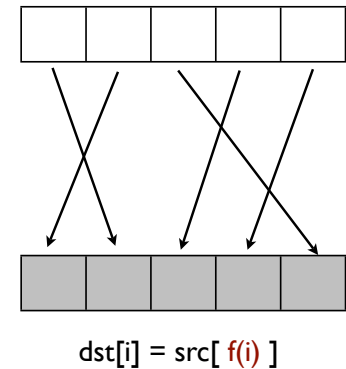


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Gather (“Pull”)

- Iterate over destination, compute source index

- Merge sort
- Sparse matrix operations
- Ray tracing
- Database query



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The Next Big Thing?

- **OpenMP** - Parallel C and Fortran extensions
- **Chapel** - Cray; streaming Fortran-ish
- **X10** - IBM; streaming Java
- **Fortress** - Sun; Guy Steele's Mathematica-Scheme
- HPC, ZPL, Cilk, Titanium, UPC, Cuda, CTM, Sh, ...

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