Stream Programming
for high-performance computing

Processor Architecture
Arithmetic Logic Unit

Multi-Processor
Arithmetic Logic Unit

Stream Programming
Arithmetic Logic Unit
Stream Primitives

- Map
- Reduce
- Scatter
- Gather

Map

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

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

Reduce (Filter)

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

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

Reduce (Fold)

- Combine elements
- Summation
- Average
- Maximum

```
(foldl + 0 '(1 2 3 4)) ! 10
```
**Scatter (“Push”)**

- Iterate over source, compute destination index
- Radix, Insertion, Quick sort
- Hash table insertion
- Permutation
- Rasterization

$$dst[f(i)] = src[i]$$

**Gather (“Pull”)**

- Iterate over destination, compute source index
- Merge sort
- Sparse matrix operations
- Ray tracing
- Database query

$$dst[i] = src[f(i)]$$

**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, ...