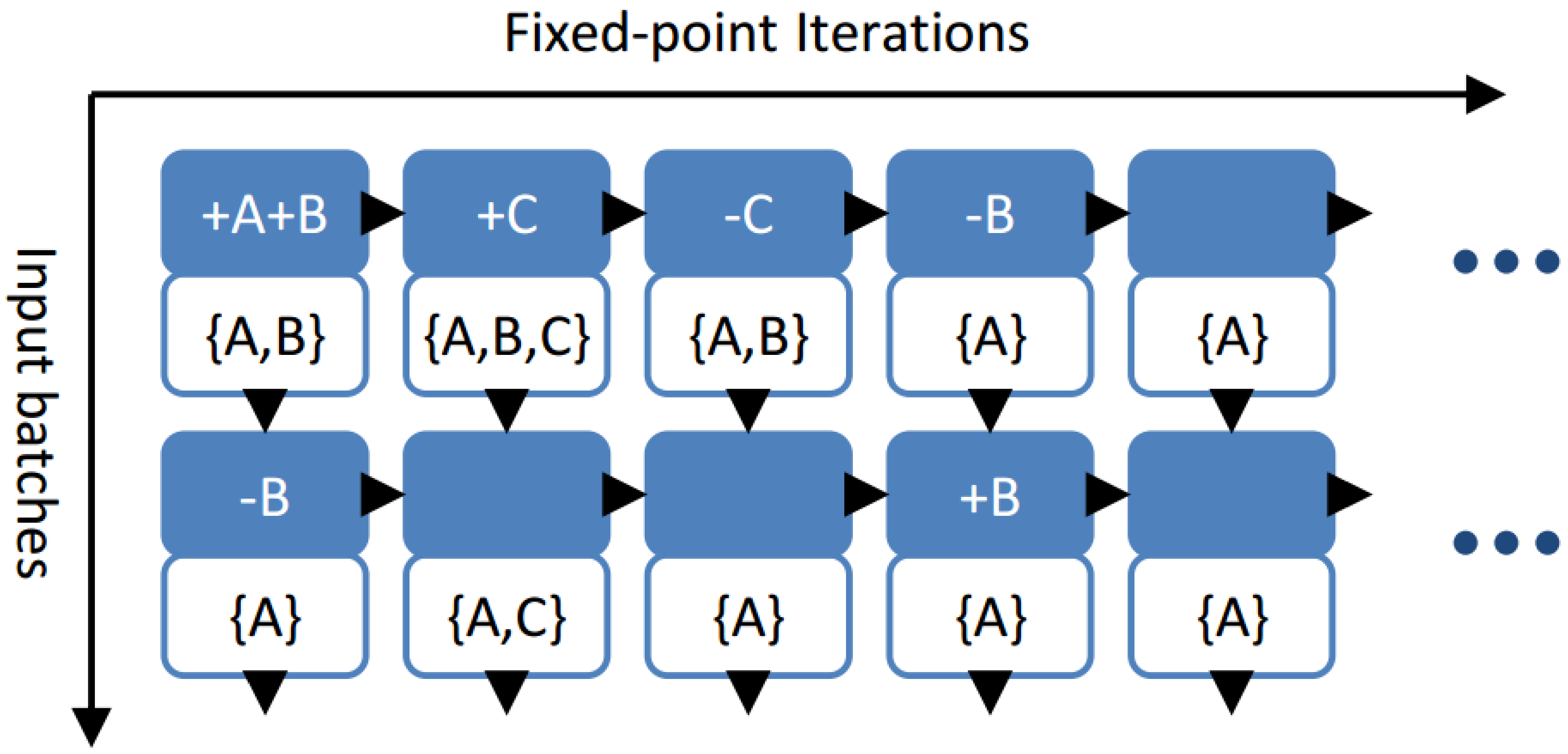
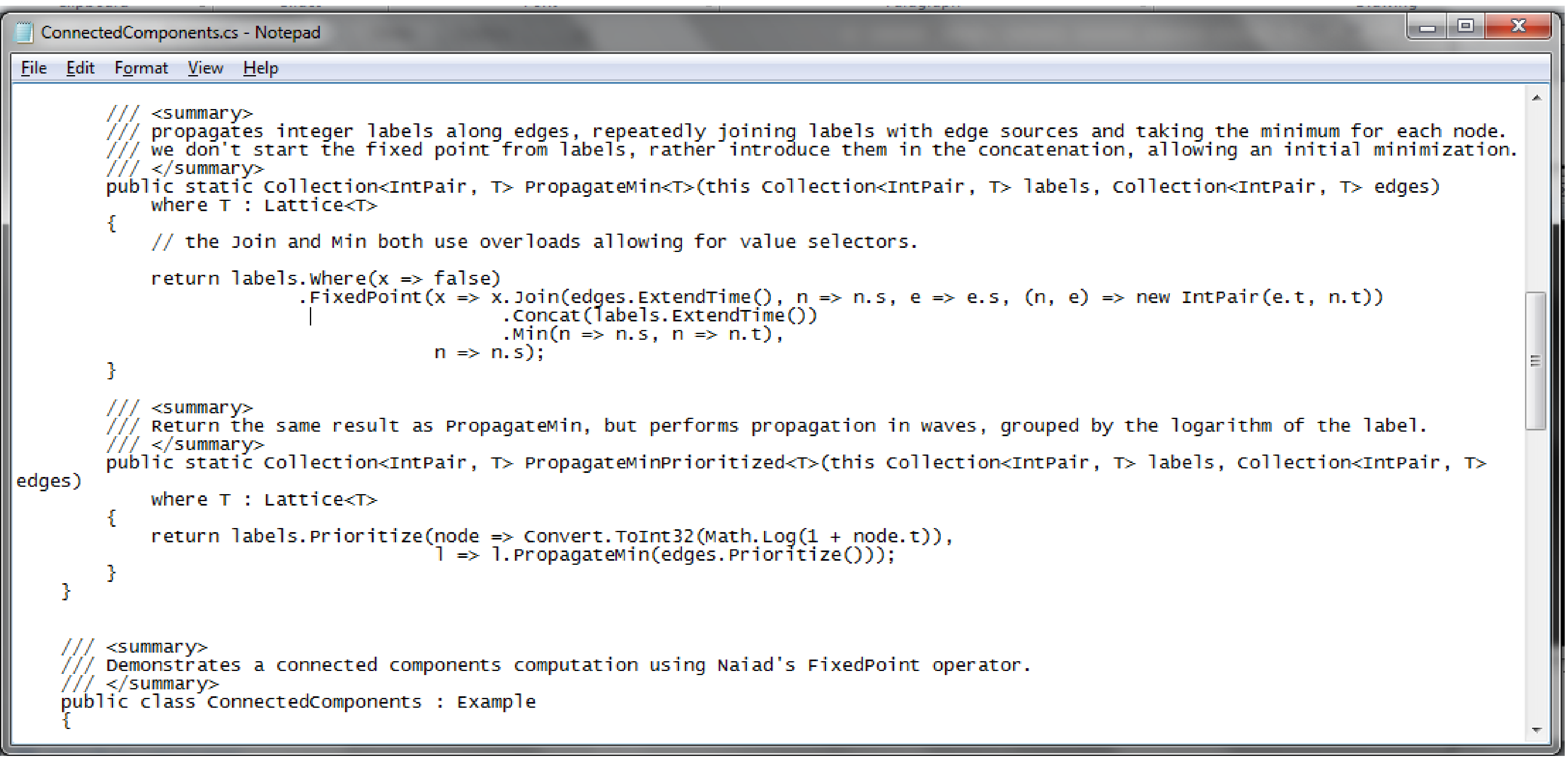
Naiad

- Composable data-parallel computation
  - Iterative
    - i.e. arbitrary dataflow graph
  - Incremental
    - i.e. allows fast recomputation after updates
- "Differential Dataflow"


Fixed-point Iterations
Input batches
+A+B
{A,B}
+C
{A,B,C}
-C
{A,B}
-B
{A}
{A}
-B
{A}
{A,C}
{A}
+B
{A}
{A}



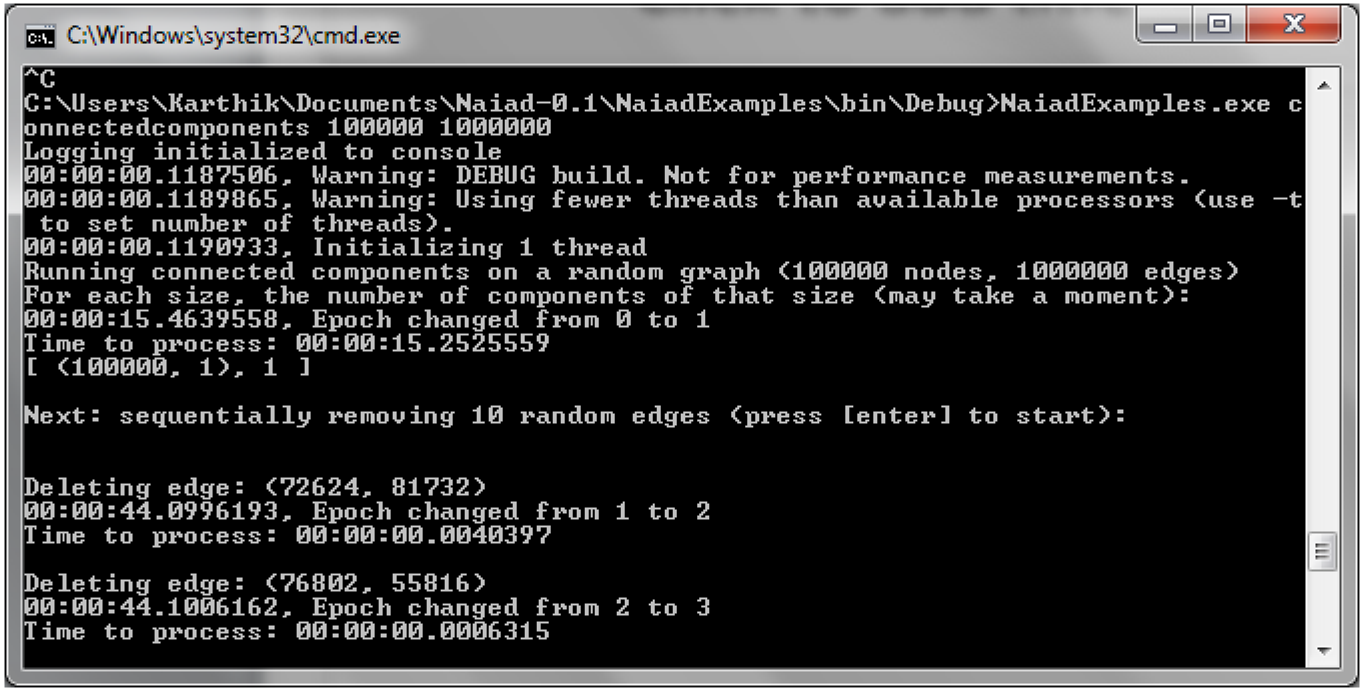
ConnectedComponents.cs - Notepad

```
        /// <summary>
        /// propagates integer labels along edges, repeatedly joining labels with edge sources and taking the minimum for each node.
        /// we don't start the fixed point from labels, rather introduce them in the concatenation, allowing an initial minimization.
        /// </summary>
        public static Collection<IntPair, T> PropagateMin<T>(this Collection<IntPair, T> labels, Collection<IntPair, T> edges)
            where T : Lattice<T>
        {
            // the Join and Min both use overloads allowing for value selectors.

            return labels.Where(x => false)
                         .FixedPoint(x => x.Join(edges.ExtendTime(), n => n.s, e => e.s, (n, e) => new IntPair(e.t, n.t))
                                           .Concat(labels.ExtendTime())
                                           .Min(n => n.s, n => n.t),
                                      n => n.s);
        }

        /// <summary>
        /// Return the same result as PropagateMin, but performs propagation in waves, grouped by the logarithm of the label.
        /// </summary>
        public static Collection<IntPair, T> PropagateMinPrioritized<T>(this Collection<IntPair, T> labels, Collection<IntPair, T>
edges)
            where T : Lattice<T>
        {
            return labels.Prioritize(node => Convert.ToInt32(Math.Log(1 + node.t)),
                                      l => l.PropagateMin(edges.Prioritize()));
        }
    }


    /// <summary>
    /// Demonstrates a connected components computation using Naiad's FixedPoint operator.
    /// </summary>
    public class ConnectedComponents : Example
    {
```



```
^C
C:\Users\Karthik\Documents\Naiad-0.1\NaiadExamples\bin\Debug>NaiadExamples.exe c
onnectedcomponents 100000 1000000
Logging initialized to console
00:00:00.1187506, Warning: DEBUG build. Not for performance measurements.
00:00:00.1189865, Warning: Using fewer threads than available processors (use -t
 to set number of threads).
00:00:00.1190933, Initializing 1 thread
Running connected components on a random graph (100000 nodes, 1000000 edges)
For each size, the number of components of that size (may take a moment):
00:00:15.4639558, Epoch changed from 0 to 1
Time to process: 00:00:15.2525559
[ (100000, 1), 1 ]

Next: sequentially removing 10 random edges (press [enter] to start):


Deleting edge: (72624, 81732)
00:00:44.0996193, Epoch changed from 1 to 2
Time to process: 00:00:00.0040397

Deleting edge: (76802, 55816)
00:00:44.1006162, Epoch changed from 2 to 3
Time to process: 00:00:00.0006315
```