Cellular Automata as “Hello, World”

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We’re going to talk about:

- Why Conway’s Game of Life is useful
- Language/Design Proposals
- Prose Composition (aka: Why it’s not as easy as it looks to be an English major)
- Where we’re going
Why Life is Useful

- Introductory Program ("Hello, World") for new programmers
- Introductory Program for new systems
- Useful in this case for both roles
  - As we’ll go into
Bugs I found in Brook

- Copying
  - Copy-in, copy-out semantics
  - streamCopy
- Stencil-ing
  - 1-D
- Commenting
What I’d like to do:

```c
while(generations--) {
    streamShape(board, 2, size, size);
    streamStencil(boardp, board, STREAM_STENCIL_CLAMP,
                   2, -1, 1, -1, 1);
    Generation(board, boardp);
}
```
What I had to do:

```c
while(generations--) {
    streamShape(board, 2, size, size);
    streamStencil(boardp, board, STREAM_STENCIL_CLAMP,
                  2, -1, 1, -1, 1);
    Generation(boardTemp, boardp);
    myCopy(board, boardTemp); //streamCopy
}

kernel void myCopy(out cell_s s1, cell_s s2) { s1 = s2; }
```
1-D Stenciling

- Seems to not work
  - 80% sure that this isn’t my error
- Get “random” values...
- 0, 16 and 134612816 popular
- Calling streamShape changes the values, but not to anything definite
Commenting

- Meta-compiler doesn’t like certain trigrams involving comments, nasty compile errors at C++ level
- }*/ and {*/ seem to be culprits
- Spaces sometimes work
- // also has its demons
Language/Design Proposals

- stdout/in as FileStream
- Sequential kernels
- Stream Programs within kernels
Allow ability to create FileStreams from FILE*, not just filename.

Trivial, but useful and important. Why?

If we stray from C philosophy here, and stray from C philosophy there, then eventually we’ll have enough unorthogonality so people’s conceptions don’t hold
Sequential Kernels

- Example: Print out stream, newline at every $n^{\text{th}}$ element
- Proposal: Use static keyword in kernels. Assures programmer of sequential semantics
- Why this isn’t as harmful as it seems:
Why this isn’t that bad:

- Used for book-keeping kernels (not much time)
- Allows programmers to not dump streams to memory, get back, etc.
- Only semantics guaranteed, may still be optimized
Stream Programs within

- Allow full stream programs within kernels, and all operations WITH a certain keyword, e.g. slow
- Allows kernels on different levels (TLP/DLP/ILP)
- Great Kernels have little kernels upon their backs to bite ‘em, and little kernels have lesser kernels, and so on ad infinitum
Example

- kernel void Generation(out cell_s newBoard, cell_s cell) {
    
    int tally = 0;
    SumNeighbors(cell.neighbors, &tally);
    newBoard = computeNext(cell, tally);

}
Stream Programs Within

- Also, circuit decomposition (from hardware design)
- Inter-procedural analysis
- Draw picture on board for this one
Problem: Consistent Nomenclature

Goal: Lay out a clear, concise and consistent lexicon for the Stream community (at least in Stanford)

Example: Stream Programming (the whole area) vs. Stream Functions (as opposed to kernel functions)
Your input

- What should mean what?
- Is there a better name for Stream Functions?
- My suggestion: Have a different name for the StreamC part of our duality
- Also: Should my intro focus on Stream Programming, or on Brook as an instance of Streaming Computation?
Where we’re going

- Considering Irregular Grids more
- Writing more test-like programs for multiple dimensions?
- Other corner cases?
Conclusion

- Having a simple program makes it easy to diagnose more complex problems, by reducing the problem domain