Fire Simulator and Fractals: using a visualization library to introduce CUDA

Tia Newhall and Andrew Danner

Computer Science Dept. Swarthmore College, Swarthmore, PA USA

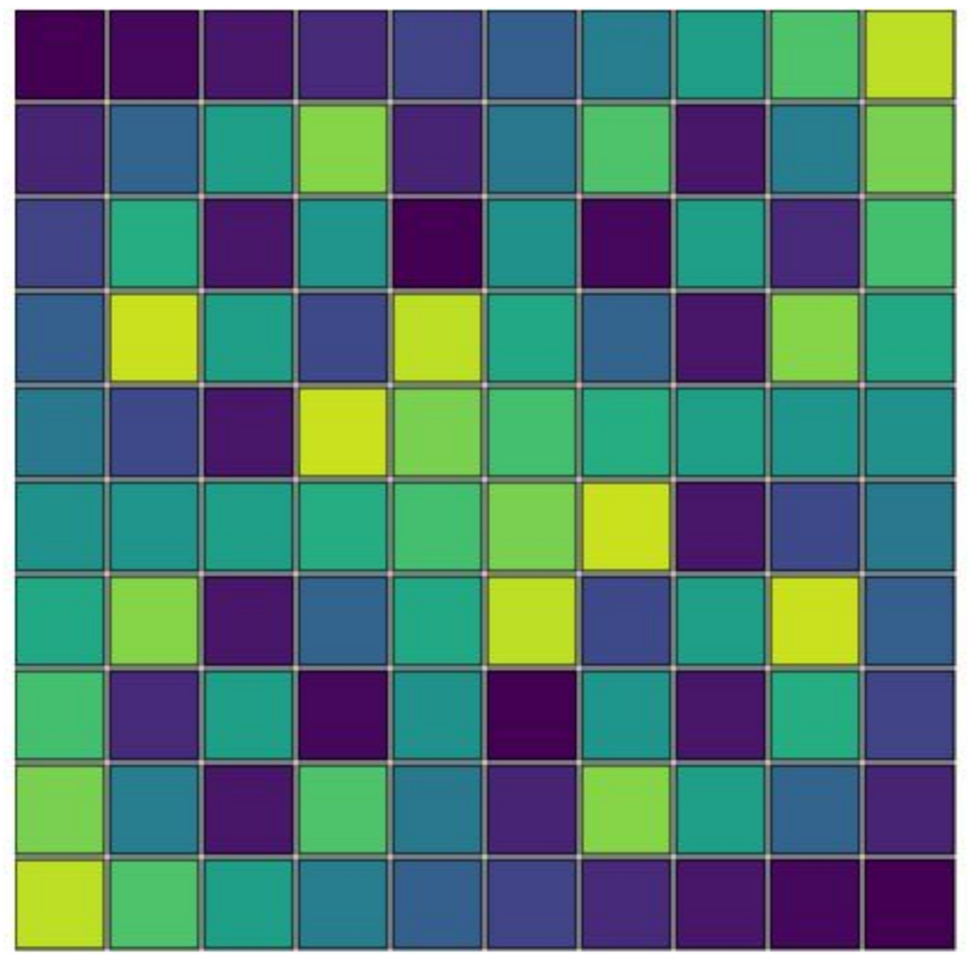
Introducing CUDA w/ Visualization

- Aids in easily seeing common CUDA bugs
  - Mapping threads and blocks to data elements
  - Cuda memory copy and initialization
  - Synchronization
- It's fun! (which aids in learning)
  - Students spend more time experimenting
- Used in 2 upper-level undergrad courses
  - Graphics: GPGPU programming on the GPU
  - Parallel & Distributed: another paradigm/model/arch

Visualization Library Design

- Easy to use Library
  - User focuses on CUDA kernels
  - Library handles OpenGL
  - Automatic animation

CUDA Kernel to assign colors (mandatory)



Users can add extra kernels/ Data buffers to extend interface

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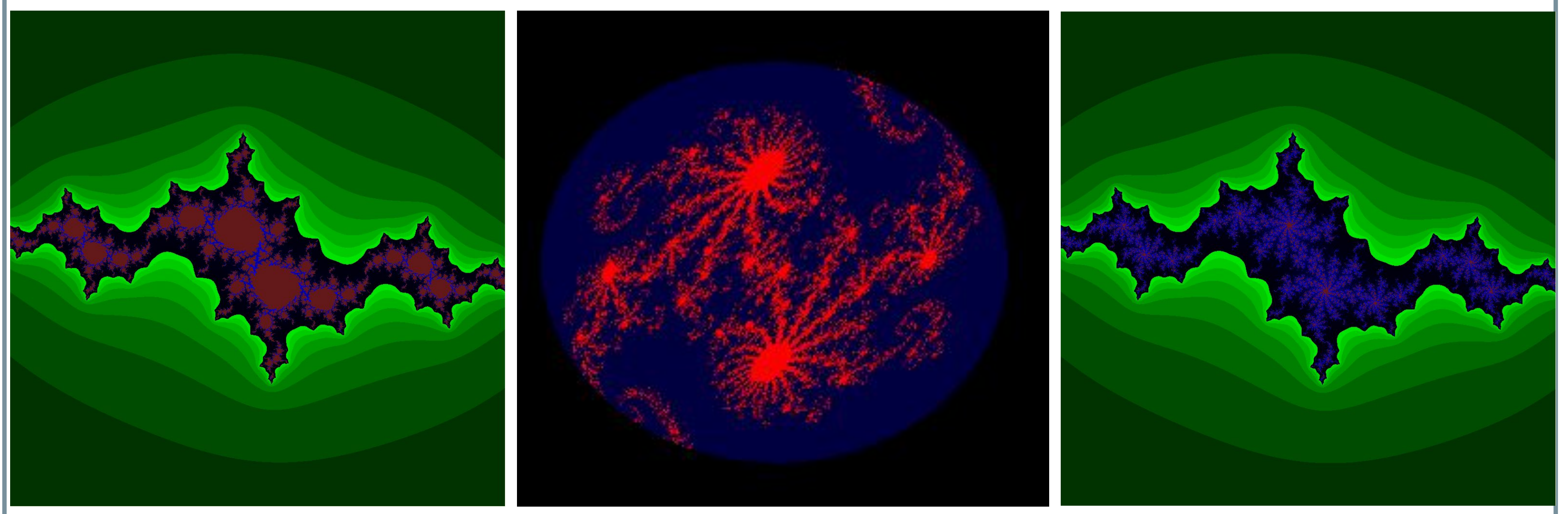
Fractals

- Julia Sets
  - Iteratively compute trajectories of complex numbers
  - Similar to vector math
- Assignment Goals
  - Connect core graphics to CUDA
  - Experiment to find good grid layouts
  - Use kernel timers
- Advanced Extensions
  - Hack OpenGL shaders
  - Image is a texture map

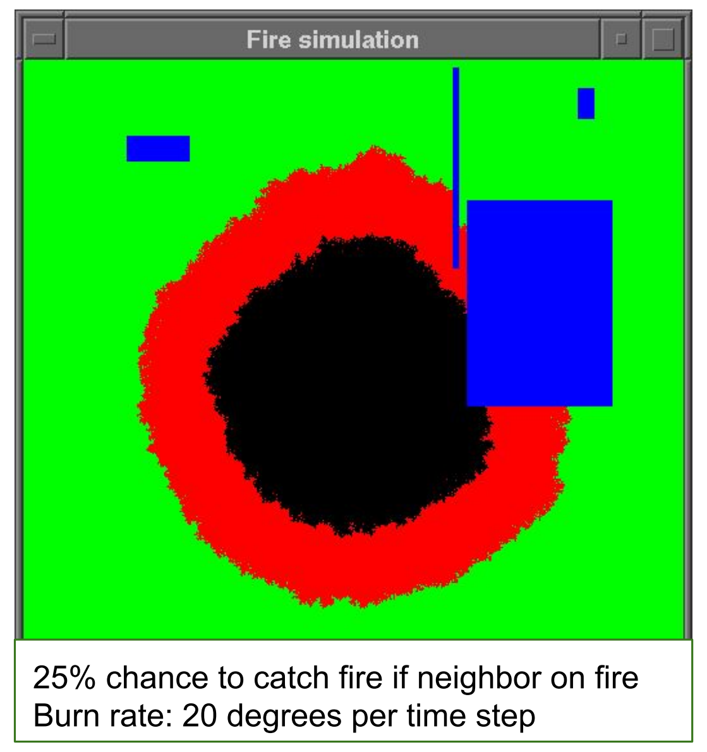


Parallel Topics

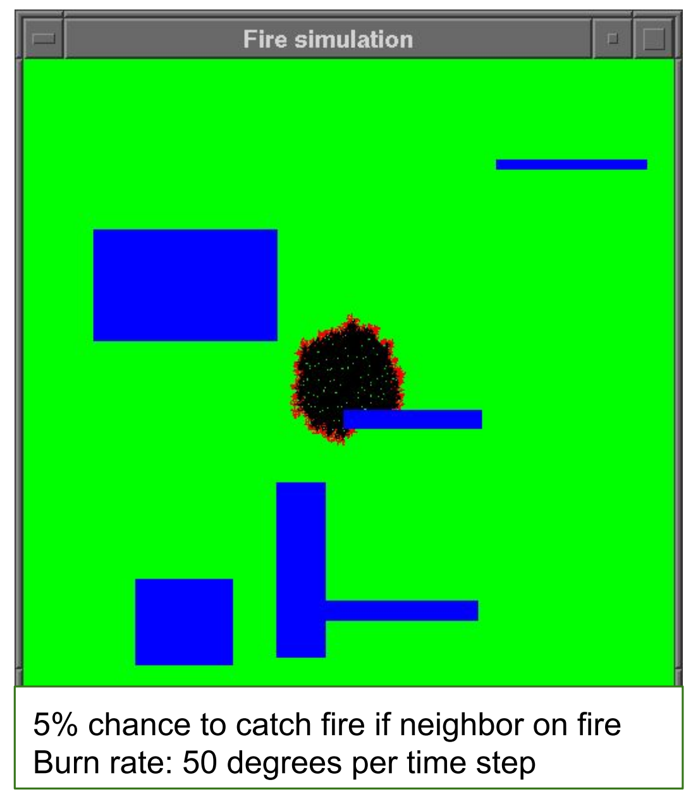
- Stream-GPU architectures
- GPGPU computing
- SPMD
- Heterogeneous Systems
- Parallel Algorithms
- Synchronization and Memory Management

Forest Fire Simulator

- Discrete Event Simulator
  - World of lakes and forest
  - World config parameters
  - Lightning strike starts fire
  - Temp cycle as cell burns
- Simulation Parameters
  - Probability cell catches fire
  - Rate of fire burn
  - Time steps to simulate
- CUDA
  - Writing kernels
  - CPU-GPU mem alloc/copy
  - Mapping 2D thread blocks to data
  - Using CuRand
  - Performance experiments with different thread/block/grid layouts

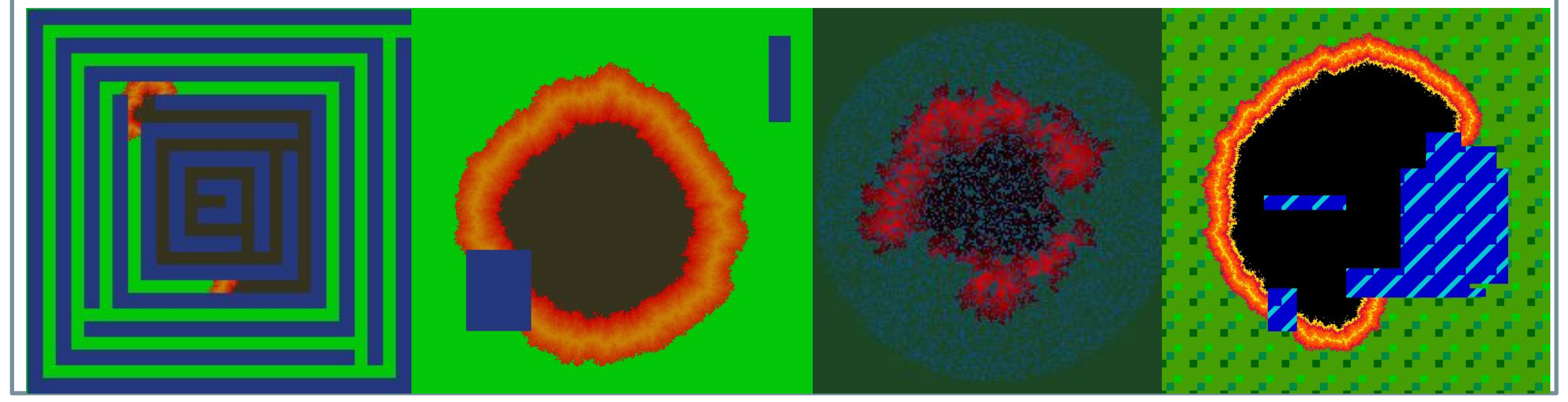


25% chance to catch fire if neighbor on fire
Burn rate: 20 degrees per time step



5% chance to catch fire if neighbor on fire
Burn rate: 50 degrees per time step

- Some Student Solutions:



More Information/Resources

https://www.cs.swarthmore.edu/edupar18