Bird Migration in Changing Habitats

Creative Commons – photo by Andreas Trepte, www.photo-natur.de)
Software Entropy Catastrophe

Refactoring ..... Fancy word for "Back to Square One"
Outline

• The remodeling project
• Diagnostics for climate change impacts and management/conservation
• Hardware acceleration with GPGPUs
• Wrap-up
A Tool for Studying Bird Migration Under Climate Change
Input Data Layer-Spatial distribution of frost free days in May

(Example layer)
Model-View-Controller

```java
public class PESA {
    private boolean alive;
    private boolean atDestination;
    private float baseSpeed;
    private int col;
    private float direction;
    private float distanceTraveled;
    private float endLat;
    private int feedTime;
    private float fitness;
    private int flyTime;
    private float fuel;
    private float fuelMax;
    private float fuelRate;
    private float fuelThreshold;
    private float latitude;
    private float leanMass;
    private String log;
    private float longitude;
    private String name;
    private int num;
    private int restTime;
    private int [a, b];
}
```

```java
public class PESAPopulation {
    private String name;
    private PESABrds[] PESABirds;
    private int currentDay;
    private boolean doneMigration;
    private PESAPopulation popRuntime;
    private PESAPopulation() {
        doneMigrating();
        getAtDestinationCount();
        getBird();
        getBirds0();
        getCurrentDay();
        getLivingCount();
        getPopRuntime();
        getPopSize();
        migrate();
        restartMigration();
        setName();
        spawnPESAs();
        toString();
    }
}
```
Diagnostic Outputs

(State Variables)
Recasting Observables

North American Bird Conservation Regions

NABCI
US Shorebird Conservation Plan
USFWS survey data
Bird Phenology Network

eBird
Pectoral Sandpiper summarized by Bird Conservation Regions

Simulation Results
Stop-over stays summarized in 1 x 1 deg lat-long
Penguin-Tesla 8 TFLOP Workgroup
GPU Compute Cluster

- Use MPI/CUDA hybrid to utilize every GPU in cluster
- Use rank to bind single GPU for 1 processor on a node
- 240 cores per GPU
- 1920 cores in entire cluster
“First Light”
Baseline Parallel Implementation

• 1,024,000 birds

• Laptop integrated card (16 cores)
  – Average 89.92 (ms)
  – Total 1798.474854 (ms)
    • 5.45x faster than unoptimized
    • 2.2x faster than cache optimized

• Desktop GTX 260 (216 cores)
  – Average 3.82 (ms)
  – Total 76.470993 (ms)
    • 113.96x faster than unoptimized
    • 45.95x faster than cache optimized

(Tim Blattner)
Optional Hardware Acceleration

(Tim Blattner)
Summary

• Model totally reworked and revamped
• Parallel implementation of key routines
• Model-View-Controller abstraction

*Predator-prey*
*Problem domain size*
*Tailored application views*
Creating Observables used for

- Convergence of evidence tests
- Diagnostics for climate change change impacts
- Management-Conservation-Public (USFWS/BCR)

45,000,000 Bird Watchers