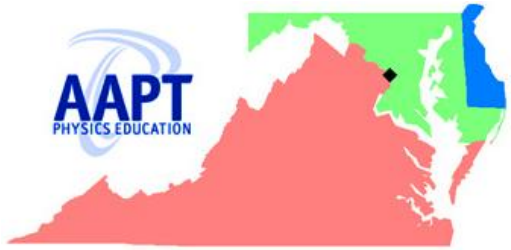


Parallel Programing to Investigate Earthquake Statistics

Eric Montag
Randolph-Macon College
Department of Physics

April 23,2016
AAPT Chesapeake Section
Spring Meeting

Outline

General Earthquake Information

Earthquake Models

Earthquake Statistics

Parallel Computing

Castellaro and Mulargia method (2003)

Our new method

Results

Future Research

General Earthquake Knowledge

One of the most destructive natural disasters

- 2011 in Japan, a magnitude 9.0 caused 309 billion dollars of damage
- 2010 in Haiti, a magnitude 7.0 caused 14 billion dollars of damage

Earthquake Faults

Photo credit: http://www.swinglecollins.com

Earthquake Models

Slip Stick

Olami-Feder-Christensen (OFC) Model

- Produces Earthquakes based on a variant of the slip stick model (2 dimensional) and is inherently sequential
- Uniform threshold stress for all sites
- Adjustable parameters
  - Lattice Size
  - Stress Transfer Range (R)
  - Stress dissipation (α)

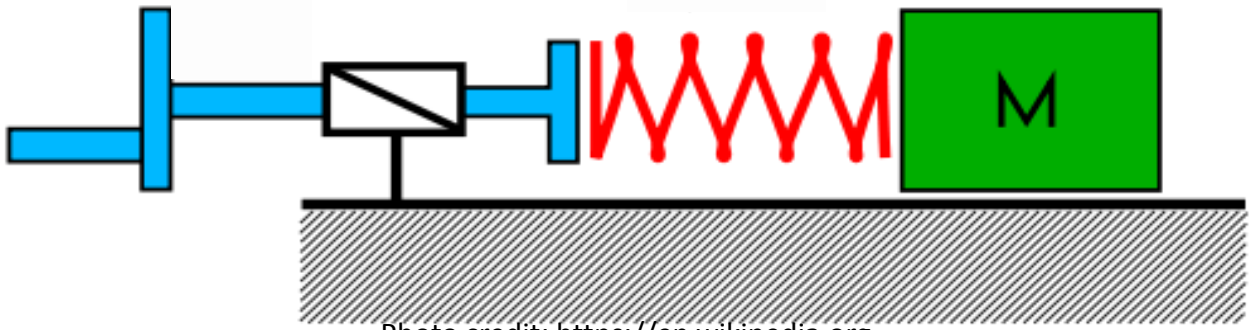
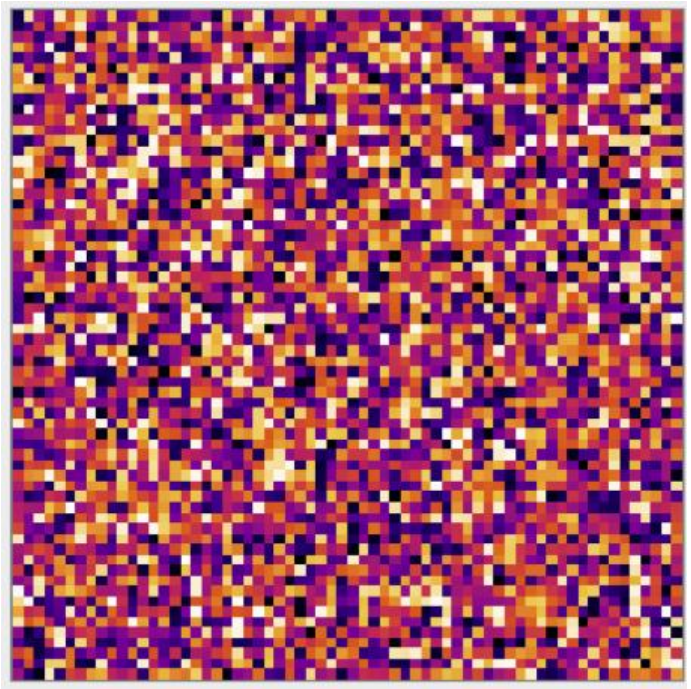


Photo credit: https://en.wikipedia.org



Earthquake Statistics

Richter scale measures size of earthquakes

- Logarithmic scale
- Ex: Magnitude 9.0 earthquake is 100 times stronger then a 7.0

Gutenberg-Richter scaling

Earthquake statistics in the OFC model

- The model produces Gutenberg-Richter statistics
- Good statistics require long computation times

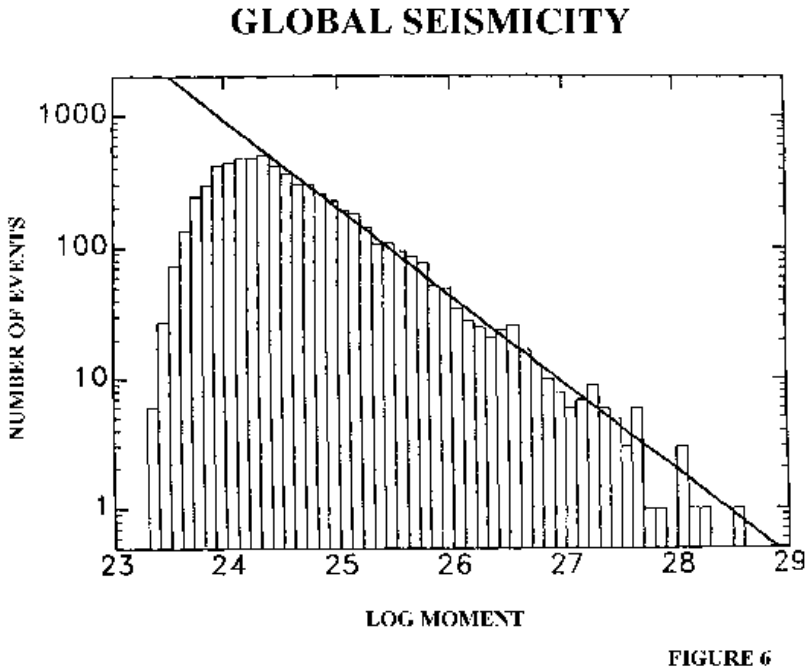


FIGURE 6

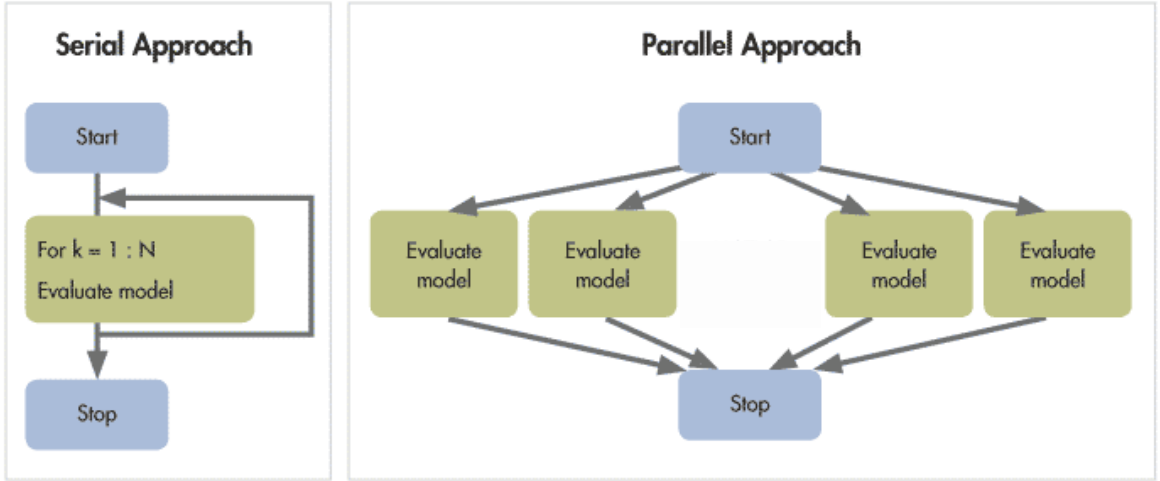
http://www2.econ.iastate.edu

Parallel Computing

Computer architecture

- Divides work among processors
- Speeds up computation by a factor of n

Problem with sharing



http://www.mathworks.com

Castellaro and Mulargia method (2003)

Connected computers together (cluster)

Experienced major problems due to sharing

Photo credit: http://www.wisegeek.com

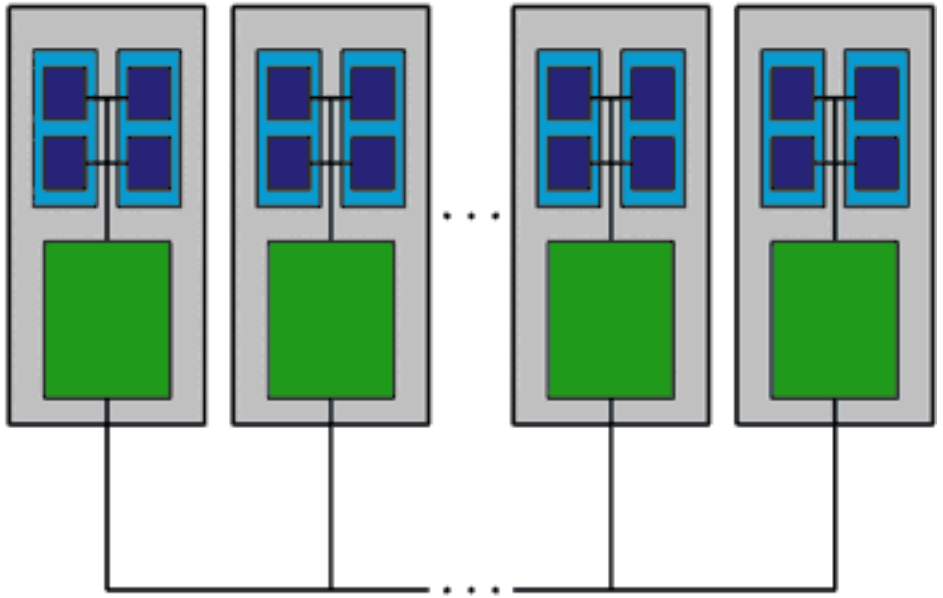


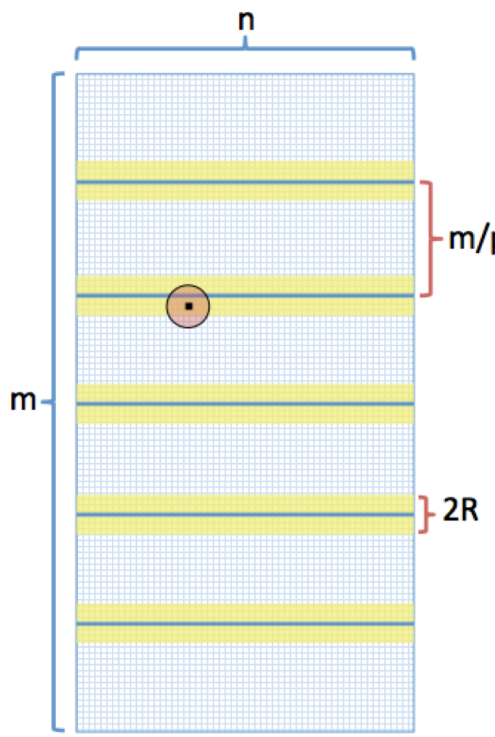
Photo credit: http://www.mathworks.com

Our new method

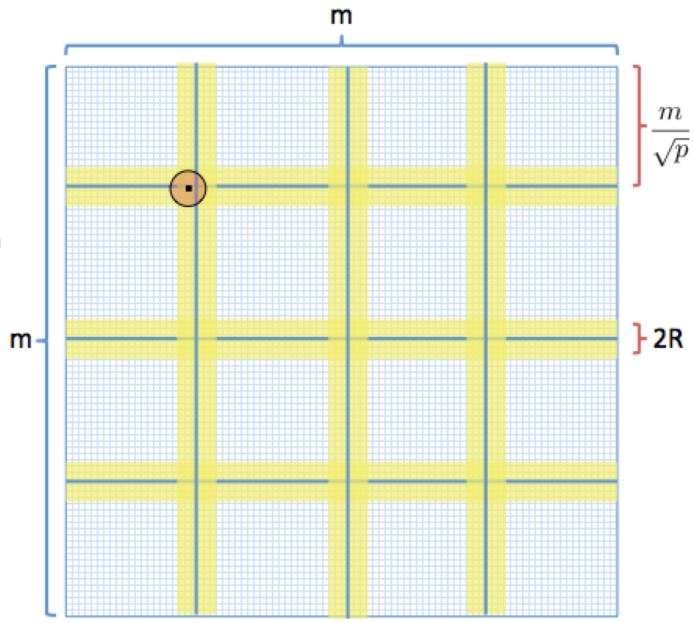
Used one computer with multiple processors
- Versus a cluster of multiple computers

Sharing memory
- Versus sending information over a network

Split the lattice up into strips
- Versus squares

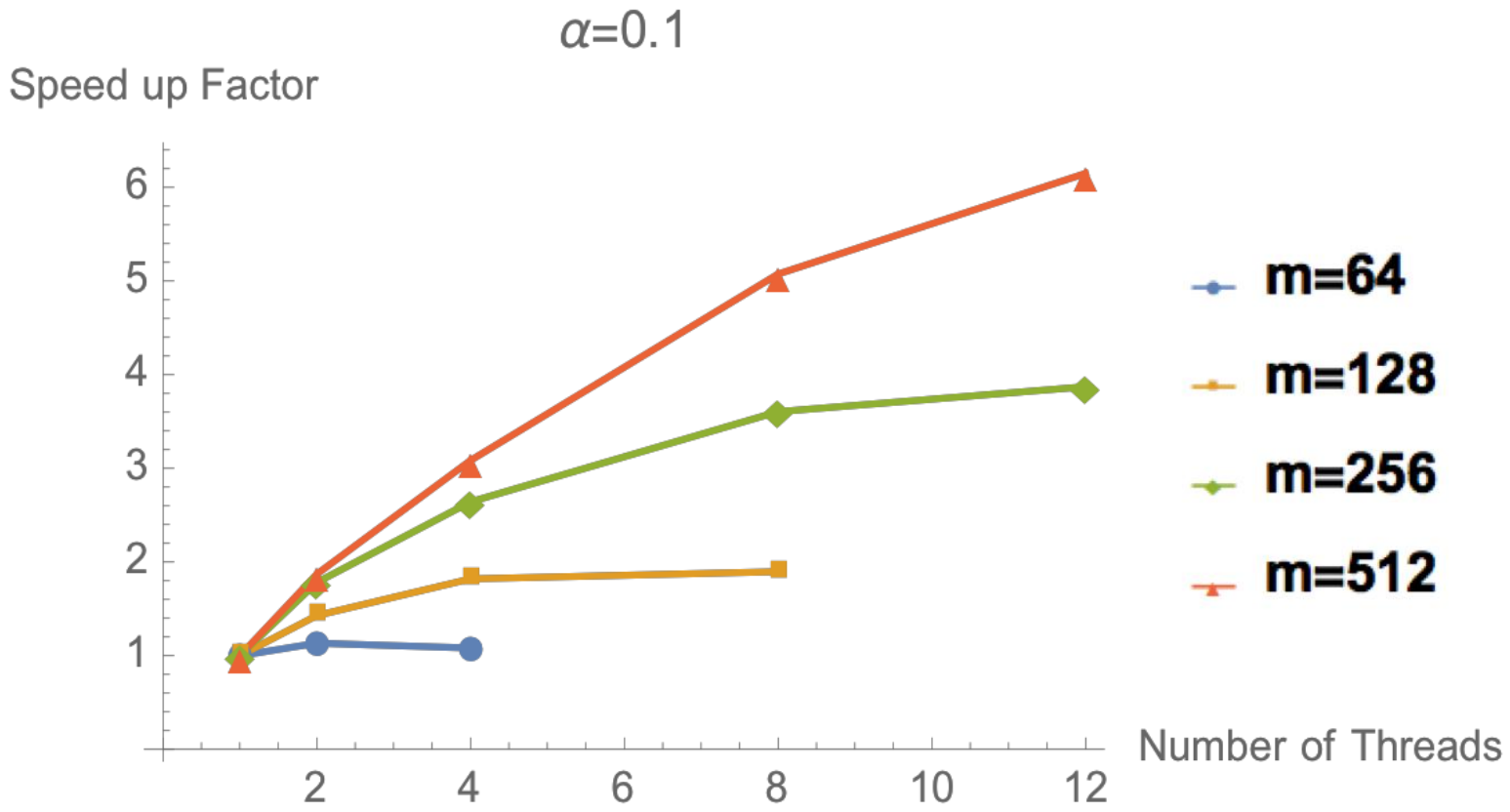


New

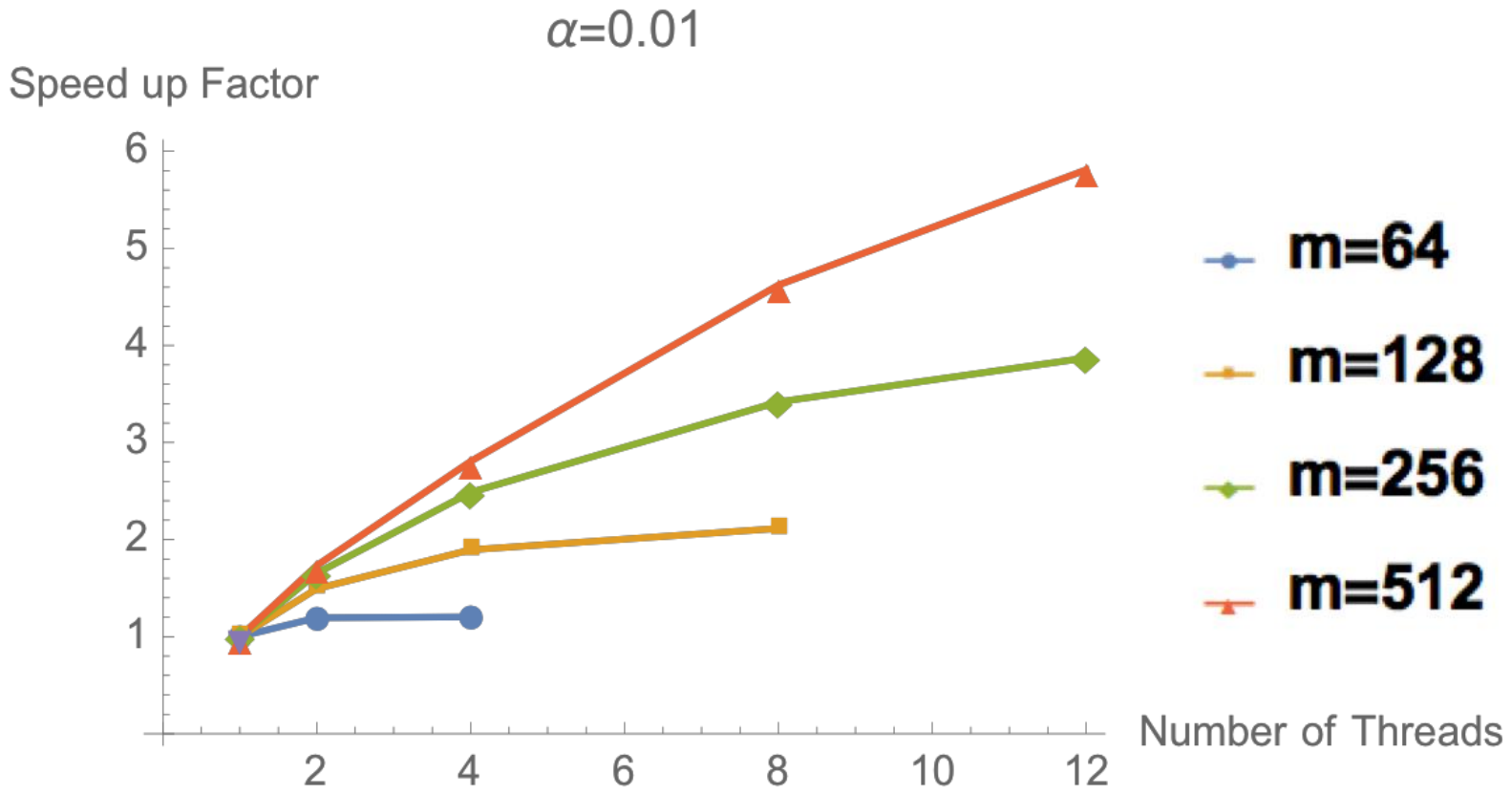


Castellaro and Mulargia method

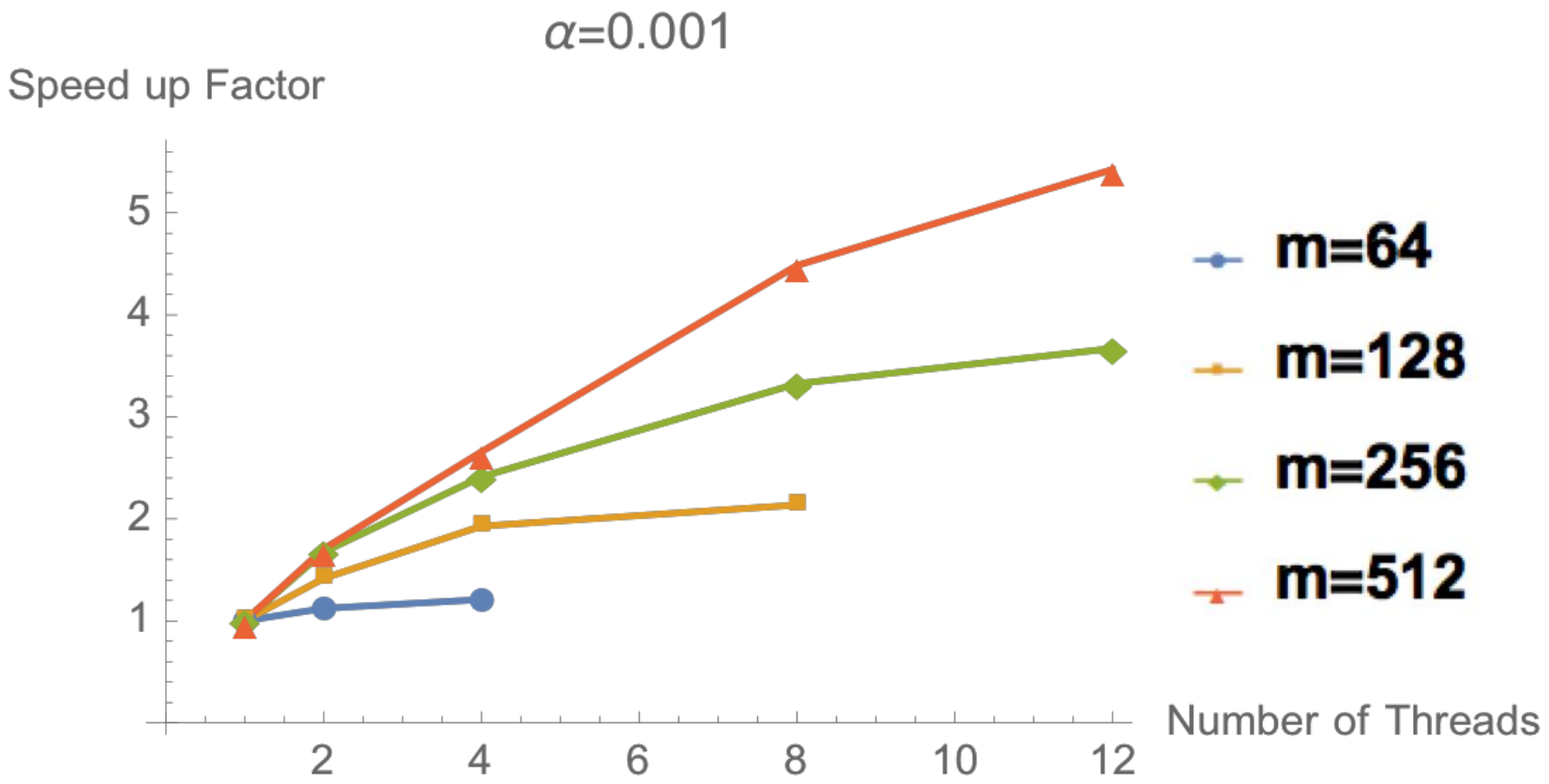
Results


α=0.1
Speed up Factor
6
5
4
3
2
1
2
4
6
8
10
12
Number of Threads
m=64
m=128
m=256
m=512

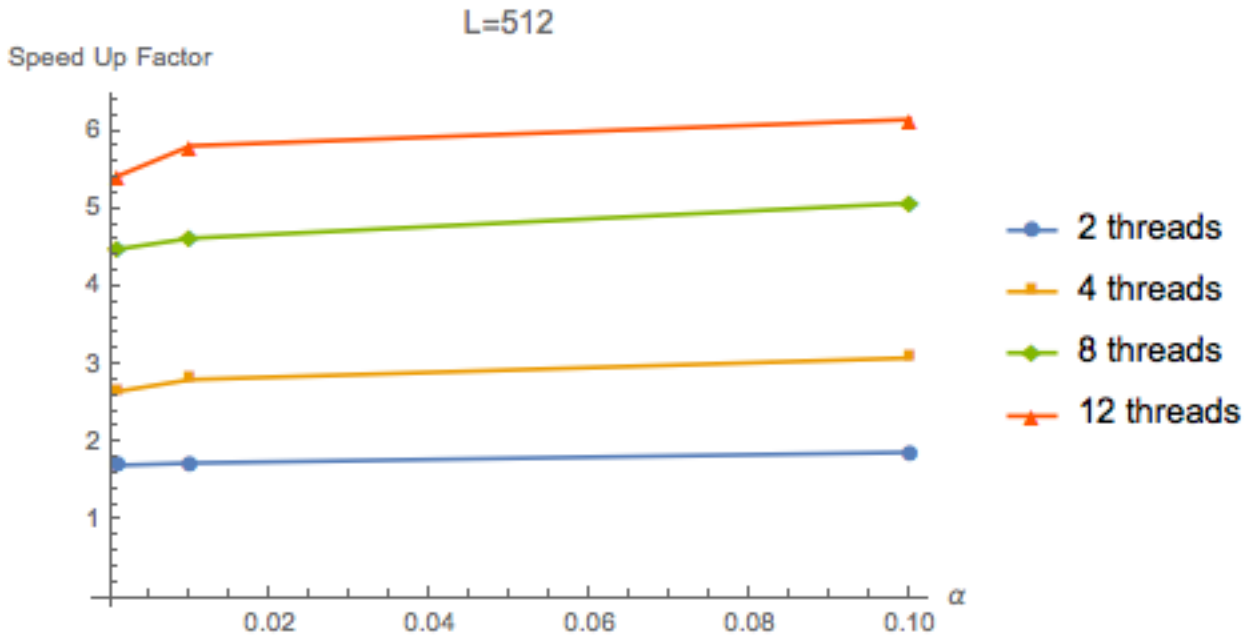
Results


α=0.01
Speed up Factor
6
5
4
3
2
1
2
4
6
8
10
12
Number of Threads
m=64
m=128
m=256
m=512

Results


α=0.001
Speed up Factor
5
4
3
2
1
2
4
6
8
10
12
Number of Threads
m=64
m=128
m=256
m=512

Results


L=512
Speed Up Factor
6
5
4
3
2
1
0.02
0.04
0.06
0.08
0.10
α
2 threads
4 threads
8 threads
12 threads

Summary and Future Research

This algorithm provides a proof of concept for a parallel algorithm on a Graphing processing unit (GPU)

Asperities/ Damage sites

Networks of interacting Earthquakes

Acknowledgments

Schapiro Undergraduate Research Fund

Doctor Rachele Dominguez

Doctor Rance Necaise

Questions