HPC in High School: Teaching and Mentoring (and funding it) And From the Student’s Perspective

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Louisiana School for Math, Science, and the Arts

2 October 2013
NAK-ə-təsh

- Natchitoches
- Baton Rouge
- New Orleans
Big Ideas

1. Big Users from Little Users Grow

2. To solve a compelling problem, students will develop the necessary skills

3. Computing is **NOT** important in every discipline

4. Student interest follows faculty passion
Big Users from Little Users Grow

```
training@training:~$ ssh bburkman@gordon.sdsc.xsede.org
Warning: Permanently added the RSA host key for IP address '198.202.104.119' to
the list of known hosts.
Password:
Last login: Tue Dec 11 11:03:30 2012 from 204.130.214.254

WELCOME TO

-----------

Rocks 5.4.3 (Viper)
Profile built 12:19 20-Mar-2012
Kickstarted 12:31 20-Mar-2012
-----------

[bburkman@gordon-ln2 ~]$  
```
Big Users from Little Users Grow

NVIDIA GPGPU Accelerator

Intel Many-Integrated-Core Coprocessor
Big Users from Little Users Grow

C/C++

Python
Big Users from Little Users Grow

Sage Cell Server

Type some Sage code below and press Evaluate.

```sage
var( "a, b, c" )
f(x) = x^2 - 2
a = 1
b = 2
d = 1.0
while ( f(b) - f(a) > 1/100 ):
    c = (a + b) / 2
    if ( f(c) * f(a) > 0 ):
        a = c
    else:
        b = c
print a, b, c
```
Big Users from Little Users Grow
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Two Types of Students

1. The Coder
2. The User
Digital Humanities

A Council on Library and Information Resources (CLIR) study of projects funded under the “Digging Into Data Challenge” found that the issues and opportunities presented by “big data” in the humanities and social sciences require basic changes in academic methods and scholarly practices.

“How was Lincoln influenced by his Southern upbringing?”

“How can I develop a new text-mining algorithm to examine Lincoln’s writings to look for Southern influences?”

Source: NEH Office of Digital Humanities
3D Printing
NPR Sunday Puzzle

Think of a word starting with G.
Change the G to a T and rearrange the letters after the T.
The result will be a new word
with the same meaning as the original word.
NPR Sunday Puzzle

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Change the G to a T and rearrange the letters after the T.
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\[
\text{giant} \quad \text{titan}
\]
Think of a word starting with G.
Change the G to a T and rearrange the letters after the T.
The result will be a new word with the same meaning as the original word.

- giant	titan
- garishly	trashily
NPR Sunday Puzzle

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The result will be a new word
with the same meaning as the original word.

  giant       tian
  garishly    trashily

Given a genome sequence starting with guanine,
change the first base to thymine
and permute some of the other bases.
The result will be a known sequence
with the same genetic function.
## NPR Sunday Puzzle

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<thead>
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Faculty Passion

Me  Search Algorithms, Data Visualization
Chemist  Visualization
Historian  “I have seen the future!”
Biologist  Computational Genetics
Courses

- Python
- C++
- Data Structures
- Java
- Mobile Apps Development
- Linear Algebra
- DiffEQ
- Vector Calculus
- Scientific Visualization
Computational Resources: LittleFe Cluster
Educational Resources: Henry Neeman
Educational Resources: LA-SiGMA REU/RET
Computational and Educational Resources: TACC
Summer 2013

Two teachers in LA-SiGMA RET
(Research Experiences for Teachers)

One student supported by LA-SiGMA
Load Balancing with MIC on Stampede

Three students in computational labs at LSU and Southern
Worked to incorporate HPC into their advisors’ work

Three students to XSEDE’13 in San Diego
Two gave a poster
Funding

- Louisiana School Foundation
- Research Assistantships for High-School Students (RAHSS)
- REU for Recent Alumni
- Outreach sections of Domain-Science Grants
- NSF/IEEE TCPP Undergraduate Curriculum Early Adopter Award
- EPSCoR Proposal under Review
Annalise and Kat:
HPC from the Perspective of a High School Student
Objective for this Project

To create an ultracovert mechanism to take a picture of an intruder

Added benefits of:

- Collecting our own data
- Experimenting with OpenMP
Safe With Sound Alarm System - Engineering Component

Circuitry Wiring/Processing Language
Safe With Sound Alarm System - Calculating Gradient

Rule: For each height, the gradient decreases (becomes darker) as \( x \) decreases and \( y \) increases, and while the rate of change in \( x \) decreases and rate of change in \( y \) increases.

\[
\begin{align*}
x_n &= d \cos \theta \\
y_n &= d \sin \theta \\
g &= 255 - \frac{255(\sum \Delta x - \sum \Delta y)}{n}
\end{align*}
\]
Safe With Sound Alarm System - HPC

OpenMP

THREAD 1
THREAD 2
THREAD 3
THREAD 4
THREAD 5
THREAD 6
THREAD 7
THREAD 8

ODD
EVEN

CALCULATE X,Y VECTORS
CALCULATE, STORE GRADIENT

MPI

HEAD NODE
WORK NODE 1
WORK NODE 2
WORK NODE 3
WORK NODE 4
WORK NODE 5

HEAD NODE:
Splits data matrix into 5 pieces
MPI_SEND to each work node

WORK NODE:
Split matrix into 4 pieces
Send piece to threads 1&2, 3&4, and so on
Odd number threads find distances
Then pass on to next thread, which calculates gradient

HEAD NODE:
Collects gradients then draws
Future Work

To reduce noise:

- Create our own sensors
- Vibration Isolation
Future Work

To reduce noise:

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Patent?
Future Work

To reduce noise:

- Create our own sensors
- Vibration Isolation

Patent?

Create a mesh from the 3D data to create a face that can be digitally manipulated with 3D software
How did we do it?
This Past Summer - Gaining Skills and Pursuing Interest

Katherine

- Parallelizing the Digital Reassembly of 3D Skull Fragments
- Learning MPI
  - Shodor Workshop

Annalise

- High Temperature Desulfarization of Biogassifer Effluents
- Learning G Programming
Our Experience with HPC

Last year’s Supercomputing Symposium
  ▶ Optimization of Matrix Multiplication with the LittleFe

XSEDE’13 Supercomputing Convention
  ▶ Programming Competition
Conclusion

- Physics and Linear Algebra
- Mr. Burkman with Numerical Analysis
- Summer Jobs and Research

The key was **Exposure**

Our motto is: ”It’s possible, so we’re going to do it.”

This project will never be finished.
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